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ABSTRACT

The nine papers included in this volume were presented during the "Working Conference on Undergraduate Education in Environmental Studies" at Dartmouth College. The rationale and strategy for environmental studies at Dartmouth College are considered in part one. Details of the proposed programs at both Dartmouth College and Williams College are reviewed in the concluding section. The main body of the volume consists of four working papers, each designed to provide a specific in-depth analysis of a key issue related to environmental education: Bioeconomics--The Science of Survival: A Proposed Philosophy for the Program; Basic approaches to the Organization of a Curriculum; Environmental Centers in a Crowded Landscape: Policies and Pitfalls in Organizing a Program; and A Case Study of New England: Examples of Public and Private Support for Environmental Education. Two additional conference papers are included: Man and Nature on Collision Course; and Environmental Dialogue: The New Education. (PR)

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A CONFERENCE REPORT

Undergraduate Education in Environmental Studies

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THE PUBLIC AFFAIRS CENTER
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Undergraduate Education in Environmental Studies

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WITH CONTRIBUTIONS BY

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Charles H. W. Foster
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Gerald Witherspoon

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I. INTRODUCTION

Environmental Studies at Dartmouth College

FRANK SMALLWOOD
Dartmouth College

AT the present time the field of environmental studies is undergoing a period of rapid, and often cataclysmic, transition at colleges and universities throughout the United States.

On the one hand, the recent report to the President's Environmental Quality Council warns that we presently face "a national shortage of broadly trained professionals to deal with environmental problems", due in large measure to the fact that historically our colleges and universities have provided "little open discussion" of environmental issues.[1]

Conversely, and somewhat paradoxically, in a paper in this Conference Report entitled "Environmental Centers in a Crowded Landscape", Dr. A. J. W. Scheffey warns that new environmental programs are now proliferating so rapidly at colleges and universities throughout the nation that they threaten to litter, and possibly choke, our educational landscape in the years ahead with an undesirable accumulation of superficial and ineffectual "paste-on" environmental institutes.[2]

These two observations highlight the fact that quality programs in environmental education have been rather badly neglected by most colleges and universities throughout the United States in past years, and that future environmental education programs promise to become *the* fashionable trend in educational circles throughout the 1970s. It is now fully obvious that a concern with environmental issues is more than a passing fancy on the contemporary college scene. Indeed, as John Fischer has argued in his trenchant description of "Survival U", a program of studies which is designed to provide a broadly-based, yet coherent, ap-

1. John S. Steinhart and Stacie Cherniack, *The Universities and Environmental Quality* (Washington: Office of Science and Technology, September 1969), p. 1.

2. A. J. W. Scheffey, "Environmental Centers in a Crowded Landscape" (see paper in this report).

preciation of man's relationship to, dependence upon, and responsibility toward his environmental surroundings represents a crucially significant challenge facing liberal arts education today.[3]

Yet, a wide variety of vital questions must be resolved before such environmental studies programs can become a meaningful reality: How can our newly emerging environmental concerns be reconciled most effectively with the more traditional aspects of the academic curriculum? Should an attempt be made to relate a broadly-based interdisciplinary field, such as environmental studies, to more specialized fields of professional expertise? What organizational arrangements are best suited to accommodate the faculty members and other practitioners who may become involved in our new environmental studies programs? What types of curriculum reform are best designed to give today's student a broad understanding of the totality of our environmental challenge, while also exploring environmental issues in enough depth to avoid a superficial overview of this complex field of study?

The Dartmouth College "Working Conference on Undergraduate Education in Environmental Studies" was held in November 1969 to probe into these and related questions. The conference, sponsored by the Dartmouth Bicentennial Year Committee and the Public Affairs Center, was organized around four working papers which were followed by a panel discussion open to all conference participants. In addition, Professor Georg Borgstrom delivered the opening conference address on "Man and Nature on a Collision Course" and Gerald Witherspoon, the President of Goddard College, delivered the closing address on "Environmental Dialogue: The New Education".

The four working papers, each of which was designed to provide a specific in-depth analysis of a key issue relating to environmental education, were:

1. "Bioeconomics—The Science of Survival". A Proposed *Philosophy* for the Program, by Dr. Sterling Brackett.
2. "Basic Approaches to the Organization of a *Curriculum*", by Dr. Dennis H. Chitty.
3. "Environmental Centers in a Crowded Landscape": Policies and Pitfalls in *Organizing a Program*, by Dr. A. J. W. Scheffey.

3. John Fischer, "Survival U: Prospects for a Really Relevant University," The Easy Chair, *Harper's* (September 1969), pp. 12–18.

4. "A Case Study of New England": Examples of Public and Private *Support* for Environmental Education, by C. H. W. Foster.

The above authors then participated in a panel session with five Dartmouth faculty members—Lawrence Dingman (Earth Sciences), George Macinko (Geography), William Reiners (Biology), Robert Reynolds (Earth Sciences), and Frank Smallwood (Government)—plus two Dartmouth seniors—George Kain '70 and William Oberst '70. In addition, Carl Reidel, of the Williams College Center for Environmental Studies, joined the panel discussion which was followed by an open question and answer exchange with the audience.

Although a wide variety of topics was covered in the papers and the panel discussion, the most crucial point to emerge from the entire conference was that there appears to be no single "ideal" formula for environmental education that is automatically applicable, or exportable, to all colleges and universities throughout the country. Instead, the central point emphasized by virtually all conference participants was that each individual college or university should inventory its own particular strengths and resources and then attempt to integrate any new environmental program into its curriculum in a manner which will enable this program to evolve as a viable component of the academic life of the institution in the years ahead. Any such formula opens up a wide variety of options, ranging from the total type of "Survival U" focus envisioned by John Fischer to more modest experimentation with environmental programs as additions to, or innovations within, an existing academic curriculum.

The environmental studies program presently being established at Dartmouth as a result of the conference is based on an inventory of Dartmouth's existing resources that are in some cases common to other colleges, and in certain cases clearly unique. As is true in many of the older liberal arts colleges at the present time, the 250 members of the Arts and Sciences faculty at Dartmouth are organized along divisional lines (i.e. Sciences, Social Sciences, and Humanities), with each division consisting of a number of academic departments which are small enough to permit relatively open and informal communication across departmental lines. Although Dartmouth's primary commitment has traditionally been to undergraduate liberal arts education, it has three excellent professional schools of Engineering, Business Administration, and Medicine, and it sponsors a number of PH.D. programs in the Sciences

and in Psychology. Once again, these professional schools and graduate programs are small enough to permit relatively easy informal communications on an interdivisional and interdepartmental basis. Finally, Dartmouth is located in a relatively unspoiled northern New England rural environment which is only now beginning to feel the pressures of an urban outreach which is emanating from the Boston-Washington megalopolis to the south and from the Montreal metropolitan area to the north. To date, however, these urban pressures have been relatively minimal and the College has developed a long-standing interest in its more rural surroundings through activities sponsored by the Dartmouth Outing Club and allied organizations. In keeping with this heritage, Dartmouth has recently joined as one of the co-sponsors of a new environmental demonstration and planning project, *New Hampshire—Tomorrow*, which is designed to enhance the environmental amenities of the northern New England area in the years ahead. At the same time, student leaders in the Dartmouth Outing Club have organized a new Environmental Studies Council which is designed to enlarge the role of the D.O.C. in environmental affairs in future years.

As a result of its evaluation of Dartmouth's particular resources, the faculty-student committee planning the new Environmental Studies Program[4] has placed special emphasis on the following four considerations:

1. *Undergraduate Focus*: The program, as initially conceived, will place its primary emphasis on providing a broadly based pre-professional environmental education at the undergraduate level. Later plans call for the development of a strong supporting research program, and eventually, a small, high quality graduate program, but the initial thrust is directed towards enhancing the undergraduate aspects of environmental education at Dartmouth.
2. *Academic Flexibility*: Because of the relatively open and informal access that exists within and between academic divisions and departments at Dartmouth and between the Arts and Sciences faculty and the three professional schools, the new program is designed to draw upon available resources throughout the Dartmouth faculty

4. The Planning Committee consisted of Prof. William Reiners (Biology) Chairman, Deans James Hornig (Sciences) and Frank Smallwood (Social Sciences); Professors Macinko (Geography), Hines (Economics), Drake, Reynolds, and Dingman (Earth Sciences); Converse (Engineering Sciences) and Messrs. Kain '70 and Oberst '70.

on an interdisciplinary basis. As is indicated below, the program attempts to provide participating students with a solid grounding in a specific departmental discipline, but it is structured in a manner which will permit students to exercise a high degree of flexibility in arranging their own courses of study.

3. *Organizational Cooperation*: Again, because of the open and informal communications which exist on the Dartmouth campus, the program is organized in a manner which will maximize cooperation with existing academic departments and with the three professional schools. Although the program staff will have a small number of "open" faculty appointment prerogatives which can be used as needed, no attempt will be made to establish a totally autonomous new environmental center or institute which would operate completely independently of the existing faculty structure. Instead, maximum efforts will be made to coordinate program needs with departmental planning, and it is anticipated that a number of the new faculty members participating in the program will hold joint appointments in existing departments, as well as in the Environmental Studies Program.
4. *Problem-Orientation Emphasis*: Following completion of an introductory core sequence of courses, all students participating in the program will engage in a series of advanced senior seminars in Environmental Policy Formulation. In these seminars, students from different academic departments will be brought together into small working teams and they will attempt to analyze a specific environmental policy issue growing out of a field project. The final result of this effort will be a student team report analyzing the selected problem and recommending a potential policy solution which is capable of implementation.

The basic components of the Dartmouth Program in Environmental Studies are described in more detail in Section IV of this report. It is worthy of special note in this introductory discussion, however, to emphasize that Dartmouth is establishing an Environmental Studies *Program*, rather than a new Center, or Institute, or Department, or Major in Environmental Studies. This development has grown out of the fact that the College has long sponsored a "Modified Major" option which has made it possible for a student to concentrate on a joint program of studies which has traditionally encompassed two or more departmental

disciplines. Under this option, students in the past selected modified majors along bi-departmental lines which permitted them to concentrate in such fields as History-Economics, Classics-Philosophy, or Chemistry-Mathematics. In 1967 a new six-course interdisciplinary Urban Studies Program was organized at the College, which was designed to serve as an additional second, or "minor" component of this modified major option. In this manner, students were permitted to concentrate their studies in any regular academic department offering a modified major and then to add six interdisciplinary Urban Studies courses to receive joint credit in such fields as Art-Urban Studies, Economics-Urban Studies, or Government-Urban Studies. This same approach was subsequently utilized to accommodate a new Black Studies Program which was voted by the Faculty in 1969.

Building on this modified major pattern, the Planning Committee has established a new five-course Environmental Studies Program which consists of three core introductory courses and two advanced Policy Formulation Seminars. Students who select this option and add it to a modified major sponsored by a regular academic department will now be able to receive joint credit in two fields (such as, for example, Biology-Environmental Studies, Geography-Environmental Studies, or Sociology-Environmental Studies). Indeed, under the options available, it will be possible for a student to devise his own basic combination of Environmental Studies with any of the modified major offerings presently sponsored by the existing academic departments at the College.

The Planning Committee believes that this type of flexibility will provide a number of distinct advantages. First, it will enable a student to obtain a solid intellectual grounding in some core discipline of his own choosing (e.g., Economics, Biology, Government, etc.) through which he can perceive some of the broader interdisciplinary issues that he will consider as part of his work in the Environmental Studies Program. In this manner, the student will have an intellectual anchor, or base, which hopefully will enable him to analyze the complex field of environmental studies in a coherent fashion. Second, this approach will make it possible to assemble teams of students from different disciplines to work together in Senior Year Policy Formulation Seminars. It is anticipated that these students will be able to learn a great deal from each other as they attempt to deal with specific issues of environmental policy. Third, the above

format will permit the new Environmental Studies Program to draw upon the total resources of the academic faculty at Dartmouth. In effect, the new Environmental Studies Program will build upon existing departmental majors, rather than compete with departments for the best students. This will not only permit the widest possible utilization of faculty, but it will also enhance the general faculty acceptance of, and cooperation with, the new Environmental Program. Fourth, the flexibility of this approach will encourage students to plan their courses to achieve maximum exposure to their own fields of intellectual interest. A student most interested in population policy, for example, could select a Geography- or Sociology-Environmental Studies combination. A student interested in ecology, on the other hand, might emphasize a Biology-Environmental Studies combination. Or a student interested in ethical issues relating to our environmental value system might couple his Environmental Studies Program with work in Philosophy, Religion, or Economics Departments. It should also be noted that, while any student who wants to receive dual credit for the modified major approach must take all five courses in the Environmental Studies Program, all Dartmouth undergraduates will be encouraged to take one or more of the three introductory courses whether or not they plan to continue with the remaining courses in the Program. As a result, it is anticipated that large numbers of students will receive at least a minimal exposure to the field of Environmental Studies in the years ahead.

A final potential advantage of the modified major approach to interdisciplinary studies is that it provides an opportunity for organizational experimentation and testing during the formative years when a wide variety of newly emerging academic concerns is buffeting colleges and universities throughout the country. The 1960s have witnessed the emergence of so many new areas of academic interest—Urban Studies, Black Studies, Environmental Studies and the like—that it is difficult at this point to ascertain how many of these will coalesce into solid fields of intellectual inquiry and how many represent more of a temporary fad. When an educational institution establishes elaborate new departments, centers, and other organizational mechanisms in response to each one of these concerns, it is often "locking in" its academic structure and curriculum in a manner which will be inflexible to change in future years. Organizational structures, themselves, exhibit a powerful self-defensive tendency to justify their own future existence, and it is often

difficult, if not impossible, to modify these structures once they have built up a solid base of bureaucratic self-interest. The more flexible programmatic format provides a wide latitude for organizational experimentation. Programs which prove to be viable can later be converted into more permanent organisms, whereas it is relatively easy to eliminate those programs which do not prove themselves over time at a given college or university. At the present juncture, it is anticipated that the new Program in Environmental Studies will provide a valuable addition to the Dartmouth curriculum, but the College will now have an open opportunity to test this program and to evaluate its potential in the light of future experience before it recommends a more permanent organizational structure for this new field of study.

During the conference panel discussion, Carl Reidel described the proposed new Williams College "coordinate-major" program for environmental studies. (See IV.) It is significant to observe how closely the Williams and the Dartmouth programs parallel each other in terms of their basic philosophy and their underlying objectives. Both programs are flexible in format, both are designed to produce a broadly based preprofessional understanding of environmental affairs, and both attempt to make maximum utilization of the existing resources available at the two colleges. In this latter regard, it is interesting to note, for example, that the Dartmouth program places more emphasis on environmental engineering and geology than the Williams program due to the simple fact that Dartmouth has a professional school in Engineering, and a PH.D. program in Earth Sciences, whereas neither of these resources are immediately available at Williams College.

This points up the desirability, indeed the necessity, for a meaningful degree of cooperation between institutions presently engaged in launching environmental studies programs, a need which is especially acute among the smaller liberal arts colleges. It is obvious that many such institutions do not have an adequate range of academic resources that span all aspects of an interdisciplinary field as broadly based as environmental studies. Both the students and the faculty at such institutions can gain a great deal from a well-conceived system of exchange visits and transfer credit arrangements.

Hence, if the field of environmental studies is to prosper in the decade ahead, this will not only require an imaginative and innovative series of cooperative interdisciplinary arrangements *within* our colleges and uni-

versities, but it will also require such cooperation *between* our colleges and universities. The nature of the challenge is obvious; the key question that now faces us is whether we will be willing to express the high degree of intelligence, commitment, and energy to meet the challenge.

In approving the new National Environmental Policy Act as his first official public commitment of the 1970s, President Nixon observed that this will be the decade "when America pays its debt to the past by reclaiming the purity of its air, its waters and our living environment. It is literally now or never."[5]

As noted above, the nature of the challenge is clear. If we can meet this challenge successfully, we will not only earn the respect of future generations, but we may well regain some measure of self-respect for our own generation as well.

5. President Nixon's statement appeared in *The New York Times* (January 2, 1970), p. 12.

II. WORKING PAPERS

Bioeconomics—The Science of Survival

A Proposed Philosophy for the Program in Environmental Studies

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"We have met the enemy and he is us" Pogo.

FROM the present state of our environment it is becoming apparent that man has reached another great turning point or watershed in his history. This demands a change in our policies and attitudes from one of population growth and free, unrestricted, competitive enterprise in exploiting an apparently open-ended environment with unlimited resources to one of population control and a restraint on exploitation requiring recycling of limited energy and resources.

Whether we can make the shift successfully may determine the fate of man and his world. This about-face in our attitudes will involve all of man's concepts, both those relating to his inner self—his treasured humanness—and those relating to the world around him. All our present culture, our religions, laws, morals, ethics, economics, politics, industry, and aspirations are based on policies, either expressed or tacit, of population growth and economic expansion. The problem is not so much a question of changing our attitudes in the face of these obstacles as it is in the speed with which this change must be made. What was once a cultural lag may now turn into a fatal attitude lag as has been so well stated by Eugene Odum in a recent editorial in *Bioscience*. As Walter Lippmann said in an interview in *The New York Times* recently, "The supreme question before mankind is how men will be able to make themselves willing and able to save themselves."

Though we may be willing to pick up this challenge, most of us and our institutions are badly in need of re-programming for the job ahead.

Twenty to forty years ago science, academia, and our institutions were being asked to do something else than is required today. Before us now lies not only the challenge, but the obligation, to create a hospitable environment for man and his associated living creatures to replace the jerry-built one with which we have endowed this age. I don't think I need to dwell on the importance of the role of our colleges in meeting this challenge to society. But, to be perfectly blunt, we know that there is widespread resistance among segments of college faculties across the country to any change from their originally conceived role as a body of independent scholars responsible only for advancing knowledge in each one's specialty. College students, many of whom are raising such a clamor, have not seen the problem very clearly either, nor come up with particularly useful solutions. However, to give just due where it belongs, our colleges and universities have given our society knowledge and technology of astounding power and irreplaceable value. Let's hope that if a new or modified approach is now called for, as seems to be the case, the faculties and administrations of our colleges will not be blind to the times. There is still opportunity to grasp the leadership; and no one is in a better position to do this, in my estimation, than Dartmouth College.

In spite of the great achievements of mankind in the past, our old systems must be fraught with flaws as judged by a few obvious facts: 1) the large and expanding proportion of the world's population that lives in hunger, want, and misery; 2) the rampant spread of wars and strife; 3) the continued and widespread existence of man's inhumanity to man; and 4) the alarming advance of man-made blight on land, water, and in the air. Man should be able to do better for himself. He prides himself that he is in control of his own destiny, yet in the few thousands of years that he has been conscious of this he has not developed a universal system for managing his own affairs that seems to be particularly successful. He has tried or is trying all sorts of systems: capitalism, communism, socialism, fascism, Christianity, Mohammedanism, Buddhism, democracy, autocracy, oligarchy, and again today some are even proposing anarchy, just to name a few of the more popular ideologies. These systems have been proposed and developed by philosophers, tyrants, theologians, politicians, political scientists, sociologists, and economists. We obviously have to have some system on which to base our actions and decisions. We now need to develop a new strategy to make

a significant turn in man's affairs from what seems like a collision course with major catastrophy, if not even extinction, to a safer course which, even if not all we would aspire to, should assure a more secure future. Perhaps the time has come for the biologist to have a try at proposing some concepts on which to base the management of human affairs, or at least, it may be time to introduce some biological principles more effectively into our operating systems.

The rather recent and growing feeling or questioning about the role of population densities and man's relationship to his environment and the ecological system also suggest that he may be ready for an infusion of biological thinking. It certainly would seem timely to examine more carefully the possible justification for taking a more biological look at our affairs and to ask what some of the principles might be that would apply and whether a practical new system can be proposed on the basis of these. To do this will require dialogue between members of all disciplines and between teacher and student. This is what I think can happen in a properly coherent undergraduate curriculum backed by a good staff of professors who themselves are willing to integrate their own scholarly endeavors toward a common goal. I have been asked to propose some sort of theme or philosophy on which the Dartmouth program could be built. What I have to propose, you will recognize, is not something particularly original but is a distillation of the ideas and concepts already well established in a variety of fields. I have summarized these into eight points which (although they are something of a mixed bag of concepts, theories, almost-laws, and ideas) I am calling principles for our purpose here. Furthermore, I am calling them the principles of Bioeconomics—a term which I think may be useful in enfolding many established disciplines and emphasizing what in ecology is called the "edge effect". In nature the margins where several strikingly different types of vegetation meet is often a peculiarly favorable habitat for many forms of life. Every grouse hunter realizes this as he skirts along the margin where a forest merges on an old field and the wild grapevines, the old apple trees, and the blackberry brambles seem to concentrate the game he seeks. This is the "edge effect". Its influence on man is seen in cities, as well, where "variety lends enchantment". Maybe our restive undergraduates would respond to an "edge effect" in academic endeavor where the whole would be greater than the sum of the parts.

Biologists have persistently resisted the notion of human ecology.

Economists have set all their operating principles on the basis of human measurements. Sociologists have consistently repudiated any connection with biology. Engineers have become increasingly skillful at doing things whether they need doing or not. Political scientists have always hoped that political policy would lead rather than follow, but politicians are never quite sure which way the wind is blowing back home. Humanists are concerned with expanding individual consciousness and sensual awareness while the world cries out for group effort for group ends. My thought then is that the concept of Bioeconomics, which concerns itself with the business of living or the economics of the whole biological world including man, might weld these divergent disciplines together and if so, could be useful as a unifying theme for an interdisciplinary program here at Dartmouth.

The Principles of Bioeconomics

The eight principles of Bioeconomics, as I see them, consist of one basic law, the Law of Survival, and seven subordinate but fundamental principles or aspects that determine or influence survival. In brief these principles are as follows:

I. The *survival of life* is the first and most fundamental principle, or law, of bioeconomics. It is axiomatic that without survival there would be no life. To survive is the objective of life.

II. *Energy is the basis of life and wealth* and its only renewable source is solar radiation which is captured by green plants. Animals are completely dependent on plants for their source of energy. Exploitation is the ability of a species to obtain energy and with this energy to obtain the other resources it needs to survive.

III. The *purpose of life is the maximum utilization of radiant energy* as it flows from the more organized form of light to the more diffuse form of heat in the process of entropy, the second law of thermodynamics.

IV. *Competition for resources* within and between species is intense but *must be controlled by an automatic, self-regulating system* in order to avoid over-exploitation and habitat destruction. Non-renewable resources must be conserved by recycling.

V. *Progress in nature is an increase in the power to exploit energy more effectively with a parallel development of self-regulating mechanisms* to

avoid imbalance and over-exploitation by any one segment of a living system. This is the driving force for evolution and evolution in turn provides for progress.

VI. *Populations must be adjusted in numbers to the availability of energy or resources and the individual powers to exploit.* All species except man are controlled by population-regulating mechanisms.

VII. *Culture or technology, man's mechanism of exploitation,* is not subject to the same evolutionary and selective controls as are genetic factors and *is defective in lacking a natural, self-regulating system* that avoids over-exploitation.

VIII. *Carrying capacity summarizes the population-resource status of a species and determines the optimal size of a population.* All management programs for plants and animals are based on this concept which suggests a basis for the better management of human affairs for long term survival and maximum quality of living.

Now let's go back over these principles and briefly consider how they would serve as a general theme or outline for coordinating an integrated, interdisciplinary program whose objectives would be to study the threats to the survival of man and his environment and to train students to cope with these in the broadest and most effective possible way.

I. Although survival is axiomatic to life, we must appreciate the living system as a whole to understand the full significance of survival and the role of the individual. The living world or biosphere, or the Life Machine as Professor Ballard called it in his lectures in last summer's Dartmouth Alumni College, is a proportionately thin layer lying on the earth at the interphase between the land and the waters (terrasphere and hydrosphere) on the one hand and the air (atmosphere) on the other. It is made up of innumerable species of plants, animals, and microorganisms each of which is made up of populations of individuals. These living organisms are interrelated with each other and with the physical and chemical factors in their surroundings in a complex system the integrity of which is critical to the survival of the whole. This, of course, is the ecological system or ecosystem. The complexity of the ecosystem we see around us today was arrived at by trial and error through evolutionary progression over four billion or more years in which successful experiments in the way of biological principles, individuals, and species

were retained while unsuccessful ones fell by the wayside. The value of the individual is in its contribution to the survival of the species and the value of the species is in the efficiency with which it performs its role or does its job in the ecosystem. A species may become extinct by being replaced by an evolving species which can outperform it. Or a species may become dysfunctional and is either eliminated from the ecosystem as a consequence or else it disrupts the ecosystem and sets it back in succession or even in evolution.

All of our scholarly disciplines, whether involved in an environmental program or not, need to place uppermost in their studies the preeminent law of survival. Perhaps the humanists may fear that this viewpoint undermines the value which they attach to the individual, yet I feel that they are faced with a far more stimulating prospect when they attempt to interpret the role of the human species and its individuals in a more cosmic and less anthropocentric way. What we must urgently seek out is to discover which attributes of the individual contribute most surely to the survival of the species.

Another ethical concern is the distinction between right and wrong or good and evil. In nature this rests strictly on this question of survival and in survival not in the short run but for the long pull. Our human estimates of goodness or morality in judging natural phenomena or, as a matter of fact, human behavior, have little foundation in reality if not based on survival values. In an endeavor like the proposed Dartmouth program the biological and physical scientists badly need the collaboration of the humanists and social scientists to re-examine and analyze the entire history of man's culture for what can be learned regarding the positive and negative factors for long-term survival of man and his environment. Since we have given such exceedingly little attention to the idea of the survival of the human species, we don't really know whether we can rely on either our instinct or our acquired behavior for continued survival, or what we need as an alternative. Still another glaring gap in our thinking is that we have never taken seriously the possibility that man may be dependent on an integrated ecosystem but have always assumed that he will soon develop a technological system that will free him from the "tyrannies of nature".

The pervasive power of the idea of survival as an "organizing principle for many fields of scholarly inquiry" has been recognized by the well-known writer John Fischer in his column *The Easy Chair* in the

September issue of *Harper*'s. In fact he goes so far as to suggest an experimental university (Survival U) "to look seriously at the interlinking threats to human existence and to learn what we can do to fight them off". The professor will not be a "detached, dispassionate scholar" but must "demonstrate an emotional commitment to our cause" and "he will be expected to be a moralist". "In every class he will preach the primordial ethic of survival". Survival then is not only the first principle of Bioeconomics but is the common denominator against which all else must be measured and judged.

II. Energy as a subject seems to turn most people off. But since energy is the basis of life and is the stuff that is absolutely vital to keep it going in the dynamic state we recognize as life, it certainly seems essential that at least something of its nature be understood by all. Actually, what most of us need to know about the physical nature of energy is not that difficult. Something about where it comes from, what it will do, how we get it and measure it, and what we can do with it will suffice. The physicists and engineers are well advanced in the study of energy although there is still much yet to be learned and applied. The biologists, especially the biochemists, physiologists, and now the ecologists, are making much progress in understanding the role of energy. Where we really need to strengthen our teaching of energy relationships is in economics and the social sciences, in order to have a more fundamental basis for the planning and management of human affairs. Perhaps the following will suggest what is meant.

Energy for the reproduction, growth, and activity of animals, including man, comes solely from food. This food is derived directly or indirectly from green plants which capture the energy of solar radiation, the only renewable source of energy for our earth. All animals, for the most part, use all their food energy, aside from reproducing and growing, for getting more food to keep going. Their entire energy budget is totally consumed in just living. Man made his most significant break from the "system" when he learned how, with tools and through plant culture and animal husbandry, to produce his food energy requirements using only a portion of his daily food energy budget. Thus he found himself with surplus muscular energy as well as time to devote to other things. This was the first formation of capital and was the take-off point for the relatively recent and spectacular rise of culture and

technology. Agriculture still remains the only renewable source of energy for man's living processes and is a critical resource base for his economy, a fact not fully appreciated now in our own developed nations where the bulk of the population is urbanized. But our agriculture is not all that we think it is, since its high productivity depends on mechanization and chemicals that draw heavily on the non-renewable sources of energy such as petroleum. In fact, for every calorie of food energy we grow in the advanced nations we consume approximately a calorie of energy from fossil fuels. We are simply exchanging one form of energy for another.

Our cities either claim to be or are trying to become self-sufficient by what they describe as the "productivity" of their industries which are mostly involved in upgrading resources. Actually, they are producing nothing in the sense of creating something that didn't exist before as does agriculture. In fact, cities are the hungriest consumers of energy in the form of food for the human effort involved and mechanical energy for mining the resources used, running the manufacturing machinery, heating and cooling the human habitations, transportation, and recreation. In a word, our urban centers, where most of our people congregate, are actually nothing but huge parasites on the energy available to the earth. One of the keys to survival of the animal and plant parasites is the necessity of not killing the host which supports them. Capital and wealth, so important in our concepts of economic development, need to be reconsidered and set firmly in the minds of all on the energy they represent. Gold, currency, and savings are worthless except in terms of the energy they can command. The world is now on a program of deficit spending as far as our energy budget is concerned. This is critical knowledge for students who will be planners and leaders of tomorrow.

III. If there is a purpose in life in a biological or technical sense, it is to make maximum use of energy derived from the sun to produce the greatest amount of living material possible. This is a fairly recent concept which we owe chiefly to ecologists. It helps to explain the great complexity of the living system and the various chains biologists have talked about such as the food chains, the carbon cycle, or the nitrogen cycle. These are simply a means of passing around of energy, slowing down its dissipation by producing life or living processes until it finally is lost as heat from the system. As has been pointed out, this highly in-

tegrated system has been developed by millions or even billions of years of trial and error. A biologist would feel that, since this system has withstood this kind of test of time, it seems mighty risky to throw it out or alter it very drastically until we are fully confident we have an improvement. Yet man is busiest at altering, replacing, destroying, or crowding out this system while he really doesn't understand what he is doing. Herein lies one of the strongest arguments for a crash university program to study and teach all we can regarding the environment which makes up our world. Every discipline has its role to play in this program.

IV. Man, with his knack for self-determination, combined with his powers of technology and his fetish for individual freedom, has flaunted one of the most universal tenets of the rest of the living world, namely its restraint on its own otherwise intense competition for resources. There will always be competition if there are potentially more individuals than resources to support them which is invariably the case in nature. But a direct, freely competitive attack on a resource leads to a mad scramble to get one's share before the next individual beats you to it and this leads to plundering and destruction. This is characteristic of man's exploitation of the resources he desires. He may have gotten away with this mostly unrestricted, or even encouraged, competition up to now because resources seemed apparently unlimited. If we haven't yet reached the point where free enterprise must be curtailed, we will sooner or later. Neither our philosophies nor our institutions are prepared for this drastic change. Our economics still rely on the faith that the market system of supply and demand combined with free enterprise will self-regulate our resource usage, and that increasing consumption is a sure mark of economic growth and progress, and that this is the cornerstone of our society.

It is interesting and significant that nature has long since pioneered this problem and would have much to teach us if we cared to learn. The details are too variable to go into here but at least three general principles of possible value to man seem to emerge. In the first place, there must be a sensing system that accurately indicates the population-resource status. Here population means total power to exploit, which is the individual power to exploit times the number of individuals. Then there must be an automatic self-regulating response to this resource informa-

tion that will lead to the proper correction of exploitation either upwards or downwards. Finally, there must be a mechanism to achieve the proper adjustment. A whole new economic and social ideology that would serve man better in his struggle for survival could be built on these principles.

V. Progress is another of our sacred cows, especially in the developed or Western world. Progress has almost as many definitions as there are philosophers, both amateur and professional. In economics it generally means an increase in economic development or the Gross National Product (GNP) or, in our terms, in the power to exploit. Nature has a similar objective: an increase in the efficiency with which energy is utilized to increase life or the biomass which, in terms of individuals or species, is an increased power to exploit. There is one tremendously significant difference, however, between man and the rest of the living world. In the latter, as the power to exploit evolves with increased efficiency, there is a parallel evolution of a self-regulating mechanism that maintains the balance or integration between all units of an ecosystem so that no one part overrides the others to the detriment of the whole. Evolution, perforce, takes place in the whole ecosystem simultaneously and this "pressure" to progressively increase the use of available energy in the environment is the driving force of evolution. Evolution, in return, provides for progress in nature. This would bring genetics and evolution into the Dartmouth Program and certainly demands the collaboration of at least economics and some of the social sciences and especially the humanities; the latter to help integrate the strictly human values with progress along physical avenues.

VI. In animals and plants, which have essentially fixed individual requirements and powers of exploitation, there can be only one kind of short-time adjustment to a change in resource availability and that is a change in population. Population regulation is therefore nature's major short-term technique for adjusting exploitation to resources. Man, on the other hand, with his variable demands and technology to exploit, has more options open to him. He can either adjust his demands and his rate of exploitation, or his populations, or a combination of all three. For so long he scarcely remembers anything else, he has been adjusting all three—demands, exploitation, and populations, upwards. As we have already said, man must now make a right about face in his policies.

Population surprisingly may turn out to be the easiest of the three to turn downwards, if necessary, and population control with all its difficult ramifications must be a dominant subject in the Dartmouth Program. If population control fails or is not favored, the only alternative is a lower standard of living and quality of existence.

VII. It now should become easier to understand what dangers an aberrant species like man brings to a balanced ecological system. His power to exploit, which is his culture or technology, is not subject to the same evolutionary and selective controls as that of the rest of the world. It can proceed at an independent rate, unrelated to the rest of the system, leading to a potentially dangerous imbalance. In fact, technology is characterized by being self-generating and autocatalytic which means that, once started, it proceeds at an ever increasing rate. All other systems in nature, either internal (i.e., physiological) or external (i.e., ecological) are dampened in their oscillations by a negative feedback mechanism in which an increase serves as a signal to decrease the process in question. In reverse, a decrease serves as a signal to increase the process. Man's technology, on the other hand, behaves as if responding to a positive feedback system in which an increase acts as signal for a further increase. It is the syndrome of the Sorcerer's Apprentice and is illustrated well by highways vs. automobiles. When autos crowd the existing roads, we think we should build more roads. Then when we have more roads we need more autos to use them fully, and so it goes. A road builder gets a big contract so he buys more heavy machinery. When this job is done, he needs another big job to keep his machinery in action. Witness the Corps of Army Engineers caught up in this kind of spiral with dam building. In nature's program, crowded roads would be a signal to cut down on auto production. But, you say, this is no way to run an economy! This is not progress! Again, nature's way would be to move slowly, by trial and error, and with small incremental steps, to allow the expansion of roads and cars, always keeping them in safe balance with the rest of the system.

I believe you can see again the need for the collaboration of many subjects in the Dartmouth Program if it follows a theme such as we are proposing here.

VIII. We now come to the final point which is the idea of Carrying Capacity. This can be a useful concept since it summarizes all the previ-

ous principles and indicates the population-resource status of a species. In a single term one can define the availability of resources and set the optimal limits of any population including that of man.

In its broadest biological sense the term Carrying Capacity is used to indicate the maximum population of any species that can be supported in its particular niche in a balanced ecological system. It is more often used as a management term by men who are manipulating populations of plants or animals, usually upwards, and ostensibly for the benefit of man himself. As a result, the carrying capacity of the world for man, at least on a short-term basis, has generally been raised. Agriculture is the most extreme example of altering the carrying capacity for a species where, often, only a single species of plant is allowed to grow on a plot of ground. The amount of grain that can be garnered from a unit of land in this way is a far cry from that which primitive man could gather from the same plot of mixed wild plants. This is not to say that the plot of land under modern agriculture produces more bulk (biomass) from the available sunlight, moisture, air, and minerals but it produces more of something man wants or can use than does a wild plot of mixed plants or animals. Agriculture is one of man's most remarkable inventions in the sense of increasing his own carrying capacity but it is also his most destructive in the sense of altering or destroying the greatest amount of natural, balanced ecosystems. The full impact of this destruction is yet to be learned.

Carrying Capacity, if not invented by, is most often used by, game managers and foresters whose objectives have been to increase the numbers of certain game animals and fish or lumber-producing forests. The difference between their programs and agriculture is that they tend to recognize more the wisdom of keeping the populations in question within bounds of an upper limit that does not seriously threaten the integrity of the whole ecosystem involved. From this point of view there is undoubtedly more to be learned from game and forest management that might be of value to the management of man as part of an ecosystem than from any other field. The future of agriculture lies in a swing away from the present emphasis on mono-culture towards a mixed culture which will have greater ecological stability. This may carry a smaller population of man but it could carry it in health and security to the environment.

It is thought that during Neolithic times there may have been a rea-

sonably stable human population of some ten million. Presumably this was the carrying capacity of the world for man at the hunter-food gatherer level of development. In place of these there are now over three billion with twice that many projected before the end of the century. Is this now the carrying capacity of the world for man and is even this the upper limit? Or has man already exceeded the carrying capacity as judged by the wide scale prevalence of starvation, misery, and habitat destruction? A game manager observing such evidence in his projects would consider this manifestly gross mismanagement and set about immediately to rectify the situation. His first move would be to establish the species requirements and the availability of resources on which to base his strategy for improved management. To me it seems absolutely essential to do the same for mankind as a basis for long-range planning for human survival and I suggest that the Dartmouth Program have as its initial and primary objective, both in teaching and research, to define the carrying capacity of the world for man. Most of the statistical data required are already available from such agencies as the UN's Food and Agricultural Organization; the U. S. Departments of Agriculture, Interior, Economics, HEW; Resources for the Future; The Conservation Foundation; The Population Foundation; AID.; etc. What is needed is an analysis and synthesis of these data in terms of carrying capacity. As a second, but even more important, objective the program should develop a strategy for the management of human affairs, based on carrying capacity, to give the optimal quality of existence for everyone without injuring the integrity of the natural environment on which man is dependent. Finally, the program should involve the Humanities and Social Sciences, in a search for ways to make man willing to save himself. This, in short, is Bioeconomics.

If the directors of the program start with no more than these three objectives, it would justify an unlimited expenditure of funds, time, effort, and talent. This could be a challenging academic program since it would involve every discipline in the college. Food, though fundamental, is only the beginning when man is considered; although this alone brings in everything from agriculture through such subjects as economics, engineering, nutrition, political science, sociology, and zoology. But, as the platitude goes, "man does not live by bread alone". There is a carrying capacity or optimal population for all sorts of other things such as the arts, aesthetics, peaceful coexistence, political manage-

ment—in other words, just plain overall quality of living. In fact, it is perfectly possible that we can feed more people than we can nourish spiritually and aesthetically. If man could turn more of his appetites and aspirations to non-material things, this alone would relieve greatly the corrosive effect on his environment; but it still would require a detailed knowledge of the technical and resource requirements to satisfy these wants. And this still would not relieve us of the demand to change our attitudes toward a population policy. The truth is that we simply have never really asked the question of what quality of life we can have for how many people. If we can answer or approximate this question in the form of a strategy for action we then need practitioners to put the action into effect. This is what the Dartmouth Program should produce—either graduates who can function directly in environmental jobs or graduates who, in their own chosen fields, will incorporate the proper ecological attitudes. This would seem to be the greatest contribution the present generation could give to the education of the next to assure survival of the human race in its broadest sense.

Basic Approaches to the Organization of a Curriculum

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MAN has been successful, so far at least, in surviving one catastrophe after another; but he is singularly inept at anticipating and preventing them. There is an obvious reason for this difference in effectiveness; for once a catastrophe is upon us there are no two ways about it; something must be done. It is much more difficult to agree that catastrophe is about to strike; we generally take a Panglossian view that the worst won't happen and that we shall get by without the necessary sacrifices. Nowhere has this fatal weakness been more apparent than in public attitudes to our environment: what the few have been saying since the time of Malthus is only now appreciated by the many.

In your new environmental program your primary aim, it seems to me, will be to train not only your own students but anyone else you can reach, to look ahead and learn how to prevent the worst consequences of our increasing population pressures. This they can do only if they are well informed and only if they are practised in the art of thinking for themselves. The educational problem to be solved is the perennial one of finding the right balance between technical and liberal aspects. So much has been written on this matter that you must not expect me to have anything new to offer; the best I can do is mention some ideas I myself might borrow in building up such a program.

One might begin by recognizing three basic themes of increasing complexity and deal first with the environment as it affects us directly, secondly, with its indirect effects, and thirdly with its combined effects on the quality of our lives.

The first of these themes—direct environmental effects—is fairly easy to grasp and is largely concerned with matters of public health. For example, as the brake linings of our automobiles wear out they turn into small particles of asbestos, which float around in the air, enter our lungs,

and cause respiratory diseases. Here is a simple example of a direct effect, which can be grasped without too much intellectual effort, but which may nevertheless have gone on for years as an unknown cause of ill health. As pointed out by René Dubos, about 80% of the pollutants in the atmosphere are still unknown.

Besides the many unknown threats to the air we breathe, there are unknown threats from thousands of chemicals in our food and water, and all the time there is less and less space for growing food for more and more people. About one million acres go out of cultivation each year in the U.S. alone; yet by the end of the century there will be 100 million more Americans. By the time people in graduate school are as old as I am now, they will be facing problems that are likely to be disproportionately greater than this 50% increase in population.

The second theme is that there are effects which indirectly threaten our survival in ways which are too subtle for the public to feel strongly about. The fundamental reaction on which all life depends is the capturing of the sun's energy by green plants. This energy then has to be converted into other forms; the processes involved are complex, and are being interfered with in a bewildering variety of ways. Thus we are polluting the oceans, which provide 70% or more of our oxygen supply and to which some people are looking for untapped sources of food; and each year we are adding to the ecosystem many thousands of tons of oil.

One consequence of our increasing demands for food—and of the continually decreasing proportion of the sun's energy we are capturing —may be that we shall have to give up eating the kinds of food we prefer. In the conversion of energy from one form to another there is an irretrievable loss of about 90%. Nutrients too are lost, not irretrievably because they at least can be recycled; but in practice most get flushed down the sewers or otherwise taken out of the system. Before the end of the century, therefore, we may have to develop a taste for an oriental type of diet by taking most of our foods from lower down the food chain.

A third theme should be the quality of our environment other than that part of it concerned with purely bodily needs. It is relatively easy to talk about matters to which there is a technological solution; but what else do we want to preserve? The writer of a recent letter in *Science* said that we are getting along all right without the moa, the dodo, and the

passenger pigeon; and indeed few people are concerned at the mounting losses of still other products of million years of evolution. We could, I suppose, equally well get along without the works of Shakespeare or Keats, and without Chartres Cathedral. Yet what kind of a life is it that is lived in purely materialistic terms? I would like to think that in any academic program such as yours, a high proportion of your students' time would be given over to humanistic studies. There is less danger, I suggest, from technology than from public indifference to the consequences of pursuing its illusory promises of a richer life.

In a recent address to the British Association, Sir Peter Medawar is reported as giving a reassuring account of the capacity of the human race to solve its technological problems. He may be at least partly right about our capacity; the real question is whether we are in fact going to use it. Despite the growing public awareness of our environmental predicaments, there is no reassurance that enough people are sufficiently concerned to bring about the politically unpopular decisions we need.

In any academic program we have to consider both form and content, and because of my own belief in the overwhelming importance of first-year teaching, I shall spend most of my time discussing these two aspects in relation to some imaginary first-year course. Towards the end of my talk I shall try to show how the form of the first-year lectures might be related to the form of the program as a whole.

During his first year a student should be guided into the field that will be of the greatest intellectual interest to him and be shown how to pursue it to his best advantage during the rest of his college life. Hence we should assign our very best lecturers to the first-year courses. In too many universities the job of teaching an introductory course is handed down to junior faculty members as a three- or four-year sentence. This is wholly wrong; inexperienced students should not be placed at the mercy of inexperienced instructors. If only we gave more attention to getting people off on the right track at the start of their college careers, we would save hundreds of wasted man-hours, not only for them but for ourselves. I would therefore urge that the first-year courses be of the highest possible caliber. We do not have an unlimited supply of first-class students from whom to select. We must attract the best into our discipline; and we must do this in competition with other apparently more glamorous programs.

It has been said that in many of today's students "moral fervor about

the ends and purposes of education replaces a pedestrian concern with objective methodology". If we can capture the imagination of such students, we can safely leave them to work out their own educational destiny. And we must indeed leave it up to them. Cardinal Newman said that if he were given the choice between two universities, one which gave its students exams all the time and put them carefully through a prescribed curriculum and another which simply brought young men and women together for four years and left them to mature and develop intellectually, he would not hesitate to choose the second alternative. I believe it is his philosophy we must go back to, despite today's vastly more difficult conditions.

These first-year courses, I would like to think, would attract all sorts of people who might have no intention of majoring in environmental sciences; they might include potential engineers, chemists, doctors, classicists, political scientists, and others. The courses would have to be intellectually challenging without requiring everyone to pick up the technical details that only a few students would eventually need. But introductory courses can fail, not only from becoming technical before capturing the students' interest, but from being too superficial to be challenging. Striking the right balance is an art one must always cultivate, but nowhere more diligently than in an introductory course.

Let me now consider some of the examples I myself might work up into suitable class material. Here I can give only a brief sketch of their content; one's students would be expected to take some part of the whole and work it over in depth. One thing I would want everyone to understand would be the complexity and interrelatedness of natural systems and human affairs; for learning to think in terms of variables that are uncontrolled and uncontrollable is a useful training whatever the students' eventual choice of profession.

To start with, I would select a really first-class study in community ecology, for example that of Fager (1968). Fager found that besides fungi and bacteria there were over 100 species of invertebrates commonly involved in the break-down of rotten logs. He could not tell from one log to another just which species he would find; but in spite of this diversity he could recognize certain recurrent groups, a rather similar total number of organisms, and a surprising similarity in the distribution of abundances within each log. For example, half the total number of organisms were contributed by two or three species only; an-

other 25% of the total was made up by a further two or three species and the remaining 25% included the others (to a total of about forty species per log). This study gives an excellent idea of the complexity of a natural community—which would come as no surprise to the biologists; but to others in the class it would bring home the difficulty of getting enough fundamental knowledge to enable us to diagnose what goes wrong when natural systems are disrupted artificially, for example, by pesticides.

Given enough time we can no doubt solve our purely biological problems. By way of contrast, therefore, let us go to the opposite extreme and consider a case history which, since it involved human beings, was less likely to be taken to a happy conclusion. My example is the story of the attempt to preserve something of the amenities of the Upper East Branch of Brandywine Creek, an area of about thirty-seven square miles near Philadelphia. This area was chosen by the Institute for Environmental Studies at the University of Pennsylvania as a pilot study of what could be done to maintain the purity of the water system, preserve the amenities for future generations, and accommodate the growth of the present 4,500 population to a projected 38,000 by the year 2020. The area, involving eight townships, was studied for about three years with help from the following organizations: The Chester County Commissioners, The Ford Foundation, The America the Beautiful Fund, The Pennsylvania Department of Forests and Waters, The Pennsylvania Department of Higher Education, The U.S. Geological Survey, and The Federal Water Pollution Control Administration. The money, about half a million dollars, was spent on consultants in such fields as hydrology, limnology, sanitary engineering, landscape gardening, law, appraising, and resource planning. The eventual proposal was to retain the beauty of this region by way of conservation easements, a system whereby certain buffer zones were to be preserved along the borders of the creek to protect woodlands, protect the steeper slopes, protect the flood-plains, and protect the water balance of the area. The plan also called for proper sewerage instead of individual septic tanks and called for reasonable growth of the population by means of cluster development instead of unplanned proliferation.

Under a conservation easement system the owner sells his right to use the land as he wishes. In so doing, he agrees to use it only in ways consistent with the plan. The cost of the scheme is the difference between

the assessed value of the land for use as the owner wishes and the value of the land managed in accordance with the agreed-upon easement principles. The easement costs for this particular project were estimated at about three million dollars. It was important if the scheme was to succeed that at least 80% of the owners should agree to participate; therefore, the right of eminent domain was to be applied if less than 80% of the landowners joined in. Unfortunately, the inhabitants of this area had had previous difficulties with power line and road easements going through their properties. The term "eminent domain" was therefore a signal for people to organize themselves to block the proposals. They formed the Chester County Freeholders and sponsored a number of advertisements in the local press, such as: "Citizens alert....Stop the land grab....Do you wish 'Big Daddy' government to perpetually restrict from 50% to 60% of the land area of entire townships? Do you believe in private ownership or state control?" This opposition was successful and the area was left at the mercy of the private developers.

A third case history might be selected to show the multiplicity of problems involved in economic developments. If the U.S. is to maintain its standard of living, it must increase its consumption of electricity by 5 to 7% per annum. Yet the utility companies (in their disinterested attempt to serve the public) are meeting opposition these days because of the land they submerge, the air they pollute, the lakes and rivers they warm up, and the radioactive emissions they produce. As a result, many of their proposals are being blocked, or at least delayed, by an alarmed and hostile public. This state of affairs may be an improvement over an uninhibited pattern of expansion; but we must all realize that we have a price to pay for this opposition.

Let us consider a scheme for increasing the electrical capacity of Manitoba by harnessing the Nelson River. To use its waters most effectively, Manitoba Hydro wishes to divert into it some of the waters from another system. If waters from Southern Indian Lake, which is on the Churchill River system, were thus diverted, they would enable the province to utilize fully the 1.2-billion kilowatt installations on the Nelson River. This cheap power would increase the prosperity of Manitoba through the development of a huge electro-chemical industry and through diversification in other ways—a necessary condition for the economic health of a prairie province. Unfortunately, this scheme would affect the lives of about 500 Indians and a number of other people

living on the shores of the lake, the level of which would rise about thirty-five feet.

This northern community is self-supporting. The Indians have a good income from the fur, game, and fish of the region and are one of the most prosperous native communities in North America. If the plan went through, the area of Southern Indian Lake would be increased from 850 to 2,000 square miles, the fisheries would be destroyed, the wildlife resources would be destroyed, the settlements would be destroyed, and the Indians would have to be resettled. As this is an area of permafrost, the soil would thaw out, trees would be dislodged and float to the surface of the lake, and a recreational area with sandy beaches and spruce-covered islands would become a shambles. In these cold northern habitats it takes much longer for biological systems to modify themselves, and the reduced flow in the Churchill River would introduce further unpredictable changes. Less water would reach the community of Churchill on Hudson Bay, tidal sediments at the mouth of the river would be modified, and animals such as Canada geese, sturgeon, and white whales, would also be affected.

What, then, should be done—increase the material wealth of the province or respect the rights of a minority and, at the same time, preserve a part of our natural heritage?

Cases such as this should be considered in great detail and reference should be made to experience gained in other countries. Sweden, for example, has a long history of enlightened treatment of those whose livelihood is affected by hydro-electric developments. We also know that things have not worked out too well for the farmers displaced by the damming of the Zambesi River. They have not been able to adapt themselves to new styles of farming; tsetse fly has increased; aquatic plants cover something like one-tenth of the surface of this enormous reservoir (Lake Kariba) and transpire a large amount of its waters. We also know that the Aswan High Dam is likely to increase the incidence of schistosomiasis. One would like to think that men would learn from the mistakes of others; but the record is by no means reassuring.

Finally, let me discuss a fourth case history, one that I used in an introductory course for first-year arts students. In teaching ecology we can, if we choose our problems wisely, take good pedagogical advantage of the fact that students already know something about them. This particular project concerned the Fraser River, which flows out at Van-

couver and whose basin occupies about one-quarter of the area of the province of British Columbia. Starting from familiar facts about the climate, geology, native peoples, and history of settlement, we went on to consider problems of mining, forestry, agriculture, fisheries, birds on airfields, and the basic biological knowledge required to solve them.

One of the more detailed enquiries concerned the salmon. Every fourth year there is an enormous catch, with those for the next three years being a great deal lower. Nobody can explain this cycle, which represents one of the most challenging biological problems in the world. These salmon come in from feeding in the Pacific, where they are exploited by the Japanese and the Russians; they come into the Fraser River and swim upstream for hundreds of miles, living on their fat reserves; they get to the spawning grounds, where they lay their eggs in gravel, which must be of a certain consistency to ensure a proper oxygen supply. The fingerlings live for awhile in fresh water and then make their way to the sea as smolts, presenting a number of fascinating biological problems of adaptation to salt water.

The Fraser River is also the biggest untapped source of power in the Pacific Northwest, and our engineers would like to dam it. In so doing, however, they would destroy a large part of the salmon industry. So once again we are faced with a conflict between two sets of values. The wealth that would be brought to British Columbia by the hydro-electric development would more than pay for the losses to the salmon industry; it would almost certainly enable one to present, to the Indians who also depend on the salmon, money enough for survival; yet is this the right thing to do? This is the type of dilemma which goes far beyond purely technical considerations. The advocates of this dam believe one can resolve the conflict by means of fish ladders; but they have no idea of the complexity of the biological problems involved. For example, the fat reserves of these salmon provide the energy for them to get up to their spawning grounds. Delays going up fish ladders can exhaust the fish, and changes in water temperature can affect their metabolism enough to destroy them. Or, assuming that it was possible to get the adults to the spawning grounds, how would the fingerlings get back to the Pacific? They would have to find their way through lakes to which they were not adapted; they would then have to go either over the top of the dam or down through the turbines. Engineers little realize how simple their own problems are in comparison with those of the biolo-

gists. Sharing one part of their education would do much to develop in each an awareness of the other's difficulties.

Here, then, are a few of the problems with which one might challenge one's first-year students. These problems involve biology, chemistry, physics, medicine, engineering, economics, history, geography, earth sciences, anthropology, landscape architecture, politics, and pollution, to name just a few.

Now, when you cover so many subjects you face the danger of giving your students a mere smattering of knowledge instead of a training in some scholarly discipline. Interestingly enough, the same problem has been vexing Oxford University, where there is to be a new honors school in Human Sciences. Students will have to pick up something about genetics, ethology, psychology, geography, sociology, and anthropology, which has led a powerful group of dons to say that a course of this kind, while superficially attractive, will not amount to much else.

These fears are legitimate; for by trying to study too many subjects one may end up a mere amateur at each. The classical solution to this problem is to train a man in the liberal arts; to train him so that he is capable of distinguishing good from bad arguments; so that he can put forward a good argument himself; so that he can write well and speak well; so that he can, in fact, apply a trained mind to all sorts of unforeseeable circumstances. Our difficulty is to know whether this approach to education, which worked fairly well during the nineteenth century, is adequate for modern times. My own feeling is that it might be no worse and might be a good deal better than any purely technical course, but that the best solution of all is to teach science and technology in a humanistic way. Such an approach would be entirely consistent with Whitehead's view that what we need in education is a knowledge of "an insistent present". Studies of the sort outlined would certainly qualify.

First-year lectures such as these would also fit another of Whitehead's schemes: that one should start with a "stage of romance". Later comes a "stage of precision", when our student, having been attracted into a discipline, is now anxious to master it, no matter how hard he has to work. He has become the truly dedicated man. It is of secondary importance what discipline he chooses for his specialist studies. Then, after two years, it may be time to emerge to take a broader look at the field and gain some appreciation of the power his special knowledge gives him.

This is the third of Whitehead's stages: once again a "stage of romance", or "stage of generalization".

Whatever plan you adopt, I hope you capture the imagination of the finest brains at Dartmouth, for there is hard work in store for them.

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Environmental Centers in a Crowded Landscape

Policies and Pitfalls in Organizing a Curriculum

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I APPROACH my topic—policies and pitfalls in organizing an undergraduate environmental sciences program—with humility, mindful of the words of Robert S. Morison, Dean of the Division of Biological Sciences at Cornell, in an article in the Fall 1967 issue of *Daedalus*: "to write an essay on education for environmental management is to write an essay on the future of the university. Nothing is alien to our environment, and thus nothing can be alien to the environmental manager." All of us—in the college and out—are environmental managers in one sense or another: as teachers, parents, professionals, consumers, voters. And while our task is not to deliberate the future of Dartmouth College, I submit that a meaningful curriculum in the environmental area will not be developed here without having far-reaching ramifications through the institution. This is simply the ecology of the situation.

The title of my remarks, "Environmental Centers in a Crowded Landscape", can be interpreted in two ways. Throughout the country more and more clusters of activity are being created to deal with all or parts of the man-environment equation. At the same time, the academic landscape itself has become cluttered, on individual campuses, with growing varieties of institutes, centers, and special-purpose programs. The question which arises is: "Do we need more, and if so why?" My qualifications for answering this question are limited, but I do have certain hunches and beliefs, based in part on personal experiences, and reflecting the findings of two current studies on this topic.

My first exposure as an undergraduate was in 1948, through a single course entitled "Conservation of Natural Resources", offered by the geographer Gilbert White, at that time President of Haverford College. The course was given out of professional interest, not within any formalized departmental framework; when President White left Haver-

ford it was dropped, and to my knowledge never reinstalled. It had a major impact upon some students, but no visible imprint on the institution.

My second exposure was a summer session on conservation offered by the Forestry Department at the University of Vermont and designed primarily for high school teachers. It involved many field trips with a floating staff of university people, supplemented with field personnel from state-federal agencies. Although conducted for several years, it never became part of the University structure.

My third exposure was akin to a laboratory experiment, being among the first group of graduate students to enter the newly established Conservation Department at the University of Michigan. The Chairman of the Department, Stanley Cain, a plant ecologist, was concerned with problems of food, people, and international resource development. The Department had come into being in large measure as a result of the sustained interest of Samuel Trask Dana, Dean of the School of Natural Resources. The Department was accepted, but not loved at once, by other parts of the school. Only two or three formal courses were offered in the early years, and the student body constituted a mixed bag of undergraduate backgrounds and interests: biology, English literature, sociology, biology, political science. They spent as much time discussing the future of the Department as their own professional careers, and they helped to shape this future. The Department survived the normal turnover of presidents, deans, and chairmen, and today, re-named the Department of Resource Planning and Conservation, has the largest graduate enrollment in the School.

My next association was through an academic appointment in two departments at the College of Agriculture at the University of Massachusetts: Agricultural Economics, and the Department of Forestry and Wildlife Management. An early assignment was to assist in the development of a university-wide program of resources training, research, and extension, drawing upon the diversity of disciplinary skills and professional competencies in a large and growing institution. For more than five years we worked through a series of interdepartmental committees and steering groups, drawing up proposals and suggestions for different combinations of centers, institutes, programs, and course sequences. While increasing numbers of faculty members in different departments became enthusiastic about the possibilities, nothing tangible was realized

during the first half-dozen years in terms of establishing a responsible and responsive focal point for environmental activities. There was insufficient direction and pressure from the top, too many forces in the other direction from the dean and department head level. In October of this year a meeting was called by the Dean of the Graduate School, and attended by some seventy-five persons, to consider ". . . the feasibility of establishing a University-wide multidisciplinary Institute for Environmental Quality. . . ." Its outcome remains uncertain.

My current association is with an institution comparable in many ways to Dartmouth. Interest in doing something about the environment came first from the President's office, and the decision to formalize this interest through the creation of a Center was made on a number of grounds, influenced to some degree by a local environmental situation. Having acquired an extensive property in the interests of promoting its optimum long-term development in terms of the College and the region, the idea of using the land as an ecological laboratory was proposed. This led to discussions with consultants, Trustees, faculty, and alumni, and eventually resulted in the decision to create a Center. Once formal institutional commitment was made, the process of discussion from within was started, and it goes on today. The general outlines of the Williams program have been determined—its research focus, its relationships with the region, its role in undergraduate education. But the Center has not yet achieved organic and binding relationships with the various academic departments upon which it rests.

My final example has to do with your own institution. At least six years ago I met several faculty members from Dartmouth and we started to exchange views on the problems and possibilities of environmental education. Here we are today, about to launch a defined program.

Various observations can be drawn from this spotty account of one person's experience. First, institutions and individuals have been working at it for a long time. Second, interest in doing something about conservation—or now environmental—education is not limited to any particular kind of institution nor to any specific set of disciplines.

Third, the process can get started in a number of ways, but some ways hold more promise than others. A single professor can create a great deal of needed environmental awareness in almost any course he happens to be teaching, but this will not necessarily create a niche in the institution capable of maintaining this function. A small group of com-

mitted faculty can make a lot of commotion, but without administrative responsiveness up and down the line, this will not necessarily lead to the kind of integrated program that is needed.

Finally, administrative action can result in the creation of a program, including financial support, a paragraph in the catalogue, and even a reshuffling of departments and course sequences. But until the idea is accepted and endorsed by the institution as a whole—faculty, deans, and departmental chairmen—it is unlikely that viable progress can be sustained.

A kind of synergistic action is needed, involving administrative initiative, faculty involvement, capacity for curriculum change, and student participation. All these are needed to make the program legitimate and dynamic. But there is a final and indispensable requirement, the presence of a small but critical grouping of individuals whose *primary*, and I underscore this word, concern is with environment as an area of synthesis. Without this element it is unlikely that *any* administrative strategy in *any* kind of institution can insure success. I judge success in terms of research accomplishment, teaching, and off-campus involvement. To overlook any of these functions is to deny the essence of the environmental challenge as I understand it. To see that they are realized will require administrative ingenuity and innovation of a high order.

The Growth of Centers

Before turning to the kinds of changes that might be needed, I want to look briefly at the growth of the center movement, centers which, in the words of my colleague on this panel, Hank Foster, are starting "to literally litter the landscape". As a base line, I go back to a Conference on Resources Training, held in Berkeley, in November, 1958, sponsored by the Natural Resources Study Committee of the Conservation Foundation. The term environment was not being used to the extent that it is today, but they were concerned with many of the same problems and bottlenecks that we are considering here. In extending invitations a deliberate effort was made to include all of those academic institutions making explicit attempts to develop programs that crossed over and among traditional departmental lines and professional areas—multidisciplinary resources training, whether through centers, departments, or schools. Approximately two dozen institutions were represented, including large universities and small private colleges.

Last year Congressman Emilio Q. Daddario, Chairman of the House Committee on Science and Astronautics, requested the Library of Congress to undertake a nationwide survey of colleges and universities to provide an overview of steps being taken to meet environmental research and training needs. Detailed questionnaires were sent to all accredited colleges, community colleges, and universities, some 1300 in all. The major question was whether a multidisciplinary unit of any kind had been created or was being planned to deal with environmental education and/or research. Related questions included detailed information on the structure, composition, administrative relationships, operational objectives, and funding. Nearly 500 questionnaires were returned, indicating that something was going on, and of these, 120 were subsequently determined as having definite programs in operation, or in advanced planning stages.

Neither the 1958 conference nor the 1969 survey can or should be interpreted as precise measures, since many institutions were clearly left out of both. But they suggest general orders of magnitude, and a fourfold increase over a ten-year period is impressive. It mirrors the groundswell of public concern with the "quest for environmental quality", and suggests several notes of caution to be kept in mind as we plan such centers in the future. First, there is already a grave shortage of qualified personnel to participate in these activities, and the supply-demand situation will probably get tighter before it eases. Particularly in relatively close-knit areas such as New England, we must keep abreast of developments across the river and up and down Interstate 91, making sure that programs of neighboring institutions fit together whenever possible, complementing one another where feasible, and at the very least attempting to avoid overt duplication of effort.

Second, some kind of informal coordination of research will be needed, so that we won't all end up working on the same problems, allowing other needs of the region to go unattended. This also applies to teaching programs, undergraduate as well as graduate, particularly for the smaller institutions which frequently do not have access to the range of skills, insights, professional competencies, and research facilities that a balanced environmental curriculum, however defined, might demand. It is easier to move students around than faculty, and the day might not be far off when a graduate or even undergraduate student in environmental studies might move successively through a series of in-

stitutions, according to his special combination of needs and interests.

These factors will become increasingly significant, and it is not too early to consider cooperative arrangements similar to the present Dartmouth-MIT exchange under your Urban Studies Program. It would be consistent with patterns of student exchange already established among the land-grant institutions and a number of private colleges in New England. But to be effective, different places will have to have different wares to offer, and this is going to demand advanced planning and collaboration.

What They Look Like

The most conclusive finding from the Library of Congress survey is that today's center building is anything but uniform. There are no models, and diversity is the only common denominator. An entirely new nomenclature is being formed, describing institutes, programs, departments, schools, and centers focused on various aspects of the environment: marine, arctic, and tropical environments; environmental arts and sciences; environmental engineering and management; urban, rural and urban landscapes; environmental biology and ecology; regional environmental analysis and design; community planning and environmental perception; environmental technology and planning; ecosystem analysis and research on living systems.

Operational objectives reflect the origin of the center—whether in response to local pressures, at the request of a govermental agency or private industry, or as specialized off-shoots of previously established research facilities. Geography is an important determinant of the kind of programs undertaken—the living laboratory idea. Some programs are geared directly to regional or national policy issues, others to basic research along specific lines—pesticides, eutrophication, landscape analysis, rural planning. In some institutions centers have been established to train or retrain professionals, and in others to channel students into graduate work. Large numbers have general programs to create informed awareness of man-environment relationships throughout the entire academic community.

A large portion of existing centers have grown out of civil or sanitary engineering, the next largest from the physical and biological sciences, medicine, and public health. Regional planning, resource management and conservation, and city planning account for most of the remainder.

The social sciences, and especially the humanities, are noticeably absent in most programs. This was recognized repeatedly as a serious shortcoming by the institutions themselves.

Factors of Success

Most respondents reported that the extent to which a center succeeds can be measured by the degree to which regular departments become involved in its programs. Often this occurs through necessity, as engineering management programs become involved in social and political processes; as sanitary engineering projects have turned to schools of medicine; as research in applied ecology has merged with allied fields of forestry, wildlife management, fisheries biology. As the range of immediate inquiry broadens through efforts at implementation, the program takes on a more interdisciplinary character. Often this requires the participation of other institutions.

Centers which established initial patterns of interinstitutional cooperation have been more effective than those which turned to outside resources as the need arose. The same applies to faculty relationships. Centers which started out working with other departments have moved faster than those which have added on as the program broadened.

In most cases participating faculty members have remained on the staff of their departments. As the center gets involved in more ambitious educational and research enterprises, increasing numbers of students and faculty get involved. In addition to participating faculty, many centers find it necessary to build up project staff to undertake specific assignments. This is done on a loan basis from government agencies, in cooperation with private consulting or industrial firms, with faculty on leave from other institutions, and with post-doctoral students. It represents a way of resolving the problem of meshing faculty interests with program needs, and also that of timing. In many instances, capable and interested faculty persons are simply not available when the need arises.

No innovations were reported in terms of administrative procedures. Most centers use some form of faculty-administration advisory arrangement for program planning and coordination. Steering committees and ad hoc faculty groups are employed to oversee specific projects or to provide policy guidance for new programs. Those centers having formal linkage with outside institutions or public agencies include such representations on their policy-making boards or committees. There

were few examples in which students participated to any significant degree in program planning and curriculum development.

Funding is a problem common to all of these new enterprises, and especially among the smaller private institutions. Public institutions reported a combination of state, federal, and university budgetary support, with university funds being applied largely to operating costs. Faculty salaries tend to be channeled through regular departmental budgets, with the center "buying" release time for individuals. Foundation support was reported in some instances, and in several cases private industrial sources were cited. Federal grants frequently limit the scope of program activity, usually being tied to specific agency needs.

The Paste-on Institute

I have been talking about the growth of environmental centers in aggregate terms. Now I wish to turn to the second aspect of my title, looking at the micro-climate within which this growth is taking place on individual campuses. A cursory review of the returns from the Library of Congress survey reveals the degree to which the academic landscape has become congested with special purpose, more-or-less autonomous units for research, teaching, and public service activities. The hyphenated fields of research and development have become commonplace, and corresponding institutional arrangements have emerged to provide focus and identity. Many are clearly related to the environmental realm, suggesting the need as well as the opportunity for integrated research and educational strategies.

But this level of campus-wide cooperation is realized more easily on organization charts than in operating practice, an observation clearly documented by a more recent in-depth analysis of environmental education conducted by the Office of Science and Technology in the Executive Office of the President. This report has just been submitted to the President's Council on Environmental Quality. Entitled *The Universities and Environmental Quality: Commitment to Problem Focused Education*, it is a provocative document which could have major impact.

To determine why only 120 of the 500 institutions responding to the Library of Congress survey were judged as having viable programs planned or underway, case studies of various programs were carried out. The findings underscore the degree of proliferation that has taken place. In one major university 157 freestanding institutes and centers

were identified; 126 in another. Although these entities are often described as interdisciplinary, the study found that many were really offshoots of existing departments, that the research they sponsored was carried independently within existing departments, and that only the sum total of separate research activities could accurately be described as interdisciplinary in nature. The origin of many of these centers could be traced back to one or two men with an idea, successful in securing funds to underwrite their project. There was little evidence of coordination even among those units concerned with different disciplinary approaches to common problems.

Describing such facilities as "paper centers" or "paste-on institutes", the study concluded that this is not a feasible approach for dealing with the larger issue of environmental quality, for applying the research and educational potential of colleges and universities to the process of environmental deterioration taking place today. The root causes for much of this deterioration can be traced directly to the compartmentalization of knowledge upon which technological development has been based, and to the ways in which technological know-how is transmitted from one generation to the next. It is due to our failure—as educators, citizens, and professionals—to anticipate side effects and to consider interrelationships.

Solutions for the environmental problems of concern today—Lake Erie, highway location, Santa Barbara, vacation homes and urban decay, thermal pollution—will not be found along disciplinary lines or in academic isolation. Environmental education, the study maintains, must become problem-oriented and action-oriented as well as multidisciplinary from the start. It must reflect the private as well as the public planning and decision-making process, and it has to become involved in events. It has to initiate and nurture on-going discussion of these issues. Its range of concern must stretch from philosophy and design through the natural and behavioral sciences, to professional fields of law, medicine, engineering, and business administration.

The study concludes that this will require a new kind of university-wide or college-wide mechanism. Unlike other areas of academic concern, the emergence of environment as an educational focus has not grown out of any particular groupings of departmental or disciplinary interests. The pursuit of any single approach to environment must of necessity move horizontally among lateral branches of the tree of

knowledge, rather than upwards from the roots of a particular discipline. In this sense it is akin to other problem-focused educational enterprises that have grown up in recent years: economic development, urban studies, black studies.

I would, therefore, give a qualified "yes" to the question raised earlier. We do need more environmental centers, but not of the paper variety. If an institution is really committed to doing something about the environment, something new is needed, regardless of the nomenclature used. But it must be more than a name on a door, a sequence of core courses, a public relations arm, or a paragraph in the catalogue. It has to have legitimacy within the institution and a certain degree of autonomy in securing the proper mix of persons. Although working through and with the departmental structure upon which knowledge is presently organized and pursued, it must also reflect and respond to the needs of the outside world.

Environmental Education at Dartmouth

What does this suggest for Dartmouth College and the program that you are about to launch? Whether it is called a program or a center or something else is less important than the role it is expected to fulfill and the responsibilities intended to be exercised. I have already indicated various functions and needs. It must constitute a recognized and effective focal point to serve in a clearing-house capacity for the clusters of environmentally-related activities building up in many academic communities today. As one example, I would cite the Winter Study Program at Williams, held during the month of January. Three years ago no projects were offered which fell squarely in the environmental area, or which involved intensive field work in our regional environment. This year half-a-dozen are being sponsored by faculty in several departments. Since our Center has already been involved in regional planning and development activities, and because we know who the people are, where the data are, the studies that have been made, and some of the problems that need to be worked on, we are helping to provide informal lines of communication among these projects. This is being done to minimize duplication and overlap, and also to provide a measure of protection for the relatively small number of public officials and agency persons in Berkshire County who might otherwise spend a good part of

January going over the same material with successive groups of students and interviewers. Independent projects are useful but coordination of effort is also needed.

The center-like capacity which I envision must represent more than an administrative compromise with departments. It must be able to serve as a bridge between the university and the outside world, a point of reference for public and private interests beyond the campus. A defined, physical location is important, a place for books, journals, and information on regional and national environmental issues. It must have resources to carry out off-campus educational activities, and it must have a continual input of brains and research findings to sustain and encourage meaningful discussion of environmental issues. It must be able to operate as a kind of academic cloverleaf, funneling different skills and knowledge towards the solution of defined problems.

It must be able to provide what the Office of Science and Technology report defines as a "home base" for faculty and students whose interests lie in these directions. This is perhaps the key element. It is not that such individuals are anti-disciplinary, that they do not appreciate standards, or that they are opposed to further development of methodology in their discipline. It is simply that they wish to employ a different approach, dealing directly with problems at hand. They have more than a marginal interest in environmental study and involvement.

It is clear to me that there are increasing numbers of such individuals casting about in search of opportunities for constructive participation. Relevancy is an overworked term, but many current environmental trends are irreversible and action now is needed. This may be why many are drawn to the field. Some have been involved in public and professional careers outside of the academic, while others, often older, have already made their mark in a discipline and are looking for a change. Many are recent graduate or post-doctoral students. Motivations and goals vary, but this represents a reservoir of talent, energy, and experience which we should strive to capitalize upon.

In most cases they will require a different kind of academic home to provide a sense of security and congenial association. Different kinds of recruitment procedures will be needed, and a re-examination of criteria for selection. To be successful in attracting and keeping this kind of individual the center or its equivalent must be on a par with other parts of the institution in proposing candidates for departmental openings, com-

sidering questions of tenure, promotion, salary—in short, the faculty reward structure.

The environmental program that I envision must be given opportunity to improvise and innovate with course requirements and content, work-study arrangements with public agencies and private industries, collaborative undertakings with neighboring academic institutions, and with the kinds of temporary and permanent staff which it employs. I would argue that these conditions must be met if we are going to provide an intellectual climate and operational framework in which genuine cross-disciplinary interaction can take place. To a substantial degree, the process will have to be geared to real problems. People do not just simply sit around and become interdisciplinary. They have to get involved, fired up, committed. When this happens, operational objectives and disciplinary interests begin to mesh.

Environmental Coalition: An Administrative Challenge

Putting all of these ingredients together may sound like a tall order, particularly for the smaller, private institutions. This leads to a final suggestion, the possibility of recombining existing problem-oriented programs and research centers into a type of environmental coalition. This would provide a broader basis for synthesis, consolidating diverse skills and interests and helping to build the "critical mass" that is so essential. For almost fifty years we have had proposals for restructuring the Federal government in the resources-planning-environmental area, along lines suggested by George Perkins Marsh 100 years ago. If we are unable to carry this through in our colleges and universities, can we expect or demand more from Concord, Boston, or Washington?

Dartmouth has access to most of the essentials for such a theoretical merger in the environmental field: a teaching hospital; an engineering school; a center for creative and performing arts; an Urban Studies Program; specialized ecological and biological research units; a senior administrative officer designated as Coordinator for Regional Programs; a recent foundation grant to foster regional activities. Can any of these things be implemented outside of an environmental context? The necessity is to begin the task.

The positive and significant spill-over effects that such concerted effort can have should not be minimized. This relationship is well-stated in a catalogue description of the new Division of Environmental Studies

inaugurated this year at the University of Waterloo, Ontario, Canada. The Division contains a Department of Geography, the School of Urban and Regional Planning, the School of Architecture, and a new Department of Man-Environment.

From the point of view of the Division of Environmental Studies, the Man-Environment program serves two vital functions. The first and most obvious is to provide a course of study to that group of students concerned non-professionally with the area, in the manner just outlined above. The second, and potentially most vital function of the Department is to serve as the mechanism whereby the professional Schools within the Division are kept in tune with the mainstream of academic life of the University by ensuring that professional program students are constantly stimulated to form and view their ideas and goals in the more general context of man and his environment.

A vigorous program of environmental studies can yield perspective not only by contact among students; it can pervade the entire academic community. This suggests the kinds of teaching innovations that we might consider. Blocks of time could be devoted exclusively to environmental topics, taught from different disciplinary positions, with combinations of faculty.

Here in New England, I would observe that such units might profitably be scheduled in the early fall and late spring, enabling students and faculty to actually get out and experience the environmental topics and perspectives being discussed: housing, pollution, highways, farms, ghettos, and gardens. An entire semester's worth of "contact hours" could be amassed over the first several autumn weekends, but it would require some reshuffling.

An entire semester or year could be devoted to intern programs with public planning or management agencies. This would be an extended independent study project. As previously mentioned, programs could be developed with neighboring institutions, giving students in urban economics opportunity to see how landscape design people actually think and operate. This would work both ways. Students in hinterland institutions could shift to the urban scene. Although running the risk of becoming undisciplined, such exposure could also heighten the element of reality.

I conclude with a final observation. It should be clear from what has been said that I tend to favor the concept of a center or program above that of a department for dealing with environmental affairs, especially

at the undergraduate level. By the same token, I think we might consider the idea of joint directorship for an environmental studies program, to discourage a single disciplinary viewpoint or outlook from becoming dominant. The focus should be kept shifting, perhaps suggesting a rotating administration, involving various departmental associations.

Conclusion

I have not related my remarks directly to the situation at Dartmouth, or to the very commendable program that has been drawn up, and this reflects a final belief which I nourish. This is simply that every institution has to work this process out on its own ground, within its own context, based on weaknesses and strengths that it knows more about than any outsider. In this sense, the utility function of consultants is limited. I close by quoting from a most perceptive and subtle book on environment, *Where Winter Never Comes*, written by Marston Bates and published in 1951. In discussing the exportation of American know-how, he states:

> But it does not all go together in one package that can be used everywhere; and as a package it is wrapped up in arrogance and sealed with intolerance. Maybe we can break it open and, taking only what we need, go to the tropics as students, to learn what we can there of nature and of man. For certainly there is much to learn.

We all have much to learn about environment, and each institution must do so on its own terms.

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A Case Study of New England

Examples of Public and Private Support and Vocational Opportunities in the Field of Environmental Education

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MY assignment today is to appraise the prospects of public and private support for training in the environmental sciences, a necessary adjunct to any program that Dartmouth or any other institution may choose to initiate. My remarks will be provincial in nature, focused primarily on a case study of New England, notwithstanding Dartmouth's national stature and its proven ability to draw students from every walk of life and region of the nation.

I intend to begin by drawing a thumbnail picture of New England, present and prospective, so as to provide a common frame of reference; then examine the potential for employment in both the public and private sectors; and finally, offer some observations on Dartmouth's most likely role in the field of environmental education.

Political scientists have argued for years as to whether New England is indeed a region. From the viewpoint of a natural scientist, there is much in favor of this presumption. The New England Province, roughly coincident with the limits of the six states, is its principal landform. More than twenty major river basins drain its 66,000 square miles of land area, and the grain of New England runs almost uniformly north and south as a result of its glaciated past.

By culture and tradition, the six states are similar, if not actually homogeneous, drawn together by the traditional political institution, the Yankee town meeting, if by no other force.

The casual visitor to New England is immediately struck by its high proportion of woodland and water, unexpected factors in a region characterized by high densities of population. We know that forests, for example, may have occupied as much as 95% of New England in 1600. By 1870, intensive agricultural and industrial expansion had cut this proportion almost in half. Today, approximately 80% of the region is

once again in forested growth. In fact, by proportion of land area in woodland, New England is more heavily forested than the timber-rich states of Washington and Oregon!

For those of you intrigued with this story of changing land use in New England, I would commend without hesitation the great Fisher dioramas at the Harvard Forest in Petersham, Massachusetts.

Politically, New England has operated as a region for many years. It has been a leader in interstate compact action, nationally, dating back to the period following the Civil War when the New England fish commissioners first experimented with uniform regulation among the six states. A New England conference of business and industry leaders, representing more than $5 billion in corporate worth, called together by the six governors in November of 1925, launched a *New England Council*, to this day the most responsible private voice for economic development in the region. In 1937, the governors themselves organized to form a *New England Governors' Conference* in order to encourage cooperative political action among the six states.

The region now boasts two federal-interstate agencies, the *New England River Basins Commission* for water and related land resource planning, and the *New England Regional Commission* for economic growth and development. These are unique instruments in which the federal government and the states actually serve as co-equal partners.

Thus, there is much to argue for a regional look at the problems of environmental education on the part of an institution such as Dartmouth located in New England. To do otherwise would be to overlook opportunities and ignore realities, in my judgment.

Let me next try to create an abbreviated picture of New England's resources with an eye to the prospects for professional employment. For this, I am indebted to two principal sources: the *New England Economic Almanac*, published by the Federal Reserve Bank of Boston, and the *Projective Economic Studies of New England* undertaken by Arthur D. Little, Inc. for the Corps of Engineers a few years ago.

At the last census, New England's population stood at just over ten million persons, three-quarters of whom resided in some twenty identifiable metropolitan areas. According to projections, this total may approach fourteen million by 1980, and nineteen million by the turn of the century, at which time eighty-five out of every one hundred New Englanders will be urban dwellers. By way of comparison, the region's

1960 population density of 166 persons per square mile will not be attained by the United States as a whole until about the year 2020. The population and land use pressures are expected to be most intense, quantitatively, in southern New England, but perhaps more drastic, qualitatively, in northern New England.

Looking at agricultural employment, the most traditional of the resource employment areas, there would seem to be little room for optimism. New England's peak period of agricultural production occurred about 1880, when some 207,000 active farms occupied more than twenty-two million acres of land. Since that time, farm populations have declined by two-thirds, the number of farms by more than a half, and at least a third of the work on farms is now performed by seasonal hired hands.

Agriculture, however, is still an important component of the New England economy, both in terms of production and the use of land. As recently as 1959, for example, some 24% of the total land area of southern New England was still in farms. Regional markets for dairy products, fruits, eggs, and poultry, are expected to remain strong, and such enterprises as truck gardening may be able to profit from the proximity of the growing megalopolis. The region's share of national markets for such products as potatoes and cranberries will more than likely remain steady. Tobacco, however, is predicted to disappear as a New England industry by the early 1980s, the victim of technological change and competing urban uses.

Employment opportunities in agriculture are thus expected to continue their decline in response to more attractive off-farm employment alternatives. Direct marketing enterprises, such as roadside sales, gallon-jug dairies, nurseries and greenhouses, may show some signs of life but, in general, there is little yet that can encourage a young professional to pursue an immediate career in conventional agriculture.

Employment in forestry must be viewed from several aspects: *the management of land*, including forest lands and nurseries, and the gathering of specialty products such as bark, needles, and maple products; the so-called *primary production* phases, including logging operations, sawmills and planing mills; and the *secondary production* phases such as millwork, veneer, plywood, and the manufacture of prefabricated structural wood products and containers. Another large segment of the industry, paper and allied products, is again either *primary* in nature, such

as pulp mills, paper mills, paper board, building paper, and building board manufacture; or *secondary*, e.g., paper board containers and boxes, converted paper and paper board products.

The forest products industry has, of course, been a prime employer in New England for many decades. In 1963, for example, nearly three thousand establishments were identified in the lumber and wood products industry alone, plus another six hundred enterprises engaged in the production of paper and allied products. These enterprises accounted for half a billion dollars in combined payrolls, and nearly one billion dollars in value added by manufacturing. Approximately 100,000 New Englanders were employed directly by these enterprises.

Although lumber production is expected to stay relatively constant for the remainder of this century, the paper production is predicted to at least double by the year 2000. Overall employment should increase by 50%, most noticeably in the secondary production or mill phases. There should also be important geographic shifts northward by these industries with Maine due to receive the largest total rise in employment, but Vermont and New Hampshire possibly the greater proportionate increases.

Forest and land management, however, the traditional institutionally-produced skills, seem to offer no appreciable prospects of large employment increases. In 1960, there were approximately 1500 individuals engaged in such practices, exclusive of the small corps of governmental and industry foresters. The most encouraging projections anticipate only a slight increase in employment opportunities in southern New England as small tract owners become interested in improving management, but this should not place appreciable demands on the existing supply of trained personnel.

In short, exclusive of the paper industry, where employment will increase sharply (but only on the mill end), the prospects for non-governmental employment are not encouraging.

Two other traditional resource areas are also worth examining briefly, although neither appears to be particularly promising in terms of potential employment. New England's once-vaunted fishing industry, plagued by problems of inefficiency and overexploitation, will do well to maintain its present level of some 6,000 full-time and 20,000 part-time employees. This projection is heavily conditional upon an increased measure of governmental support for fleet modernization, as well as

satisfactory international agreements for the conservation of the fisheries.

New England's mineral industries, primarily sand, gravel, and clay extraction and dimension stone quarrying, will continue to account for less than 1% of the total employment in the region. Northern New England—primarily the state of Maine—may enjoy a slight increase in employment as demands for sand and gravel respond to economic development, and some of the promising new mineral sources are developed.

An amusing outgrowth of the census data was the discovery of a seemingly high employment of New Englanders in the petroleum, metal, and coal mining industries. Upon closer examination, these were found to be the executives of national companies who preferred the amenities of New England living to any other location.

Major water-using industries, another traditional component for New England, should also be mentioned, including the chemicals, primary metals, machinery, and transportation equipment manufacturers. Estimated at a conservative $6 billion in value-added for 1970, these industries may reach as much as $14 billion by the turn of the century. The hottest growth component, both for this business category and for the New England economy as a whole, is expected to be the electrical machinery industry.

Before leaving the private sector for a look at government employment possibilities, let me touch on one other aspect of the non-governmental picture, the burgeoning private conservation organization movement. I need not advise this audience of the vitality of citizen efforts in New England, stimulated as they have been by the region's unique conservation commission machinery and the widespread and growing civic concern for environmental quality.

Probably few regions of the United States have been so richly endowed with organized local conservation interest groups as New England. The early spurs to action were items now taken for granted—fish and wildlife conservation, songbird protection, forest fire control, public reservations, and forest management. By a curious paradox, much of the vitality of New England's private effort derived historically from the absence of established governmental responsibilities. The jobs to be done were thus clearly defined; there was a sense of immediacy to the needs; and there was no means other than private initiative to accomplish the desired ends.

Of the nearly one hundred private conservation organizations now established in New England, only four are sizeable enough to have any appreciable staff. I include in this category the Massachusetts Audubon Society, the (Massachusetts) Trustees of Reservations, the Society for the Protection of New Hampshire Forests, and the Appalachian Mountain Club.

Although I fervently hope that increased financial support will permit a higher level of employment at the private organizational level in the future, this prospect does not appear likely for sometime. One must recognize that a large share of conservation's basic credibility lies in the volunteer nature of its adherents and the widespread opportunities for personal participation that characterize its efforts.

In terms of direct governmental employment opportunities in conservation, the prospects would appear to be only mildly encouraging despite the four-fold increase in government employment projected by the year 2020. A quick survey of the principal resources agencies in each of the New England states revealed less than 2,000 individuals directly engaged in full-time resources work above the level of laborer or clerical employee. Largely civil service in nature, less than 10% of these positions turn over from year to year. In fact, the greatest number of recent vacancies resulted from the retirement of CCC-vintage employees, and the next appreciable turnover should not occur until the decade of the late 1980s.

For the two southernmost New England states, governmental resources positions grew approximately 10% during the past five years. The remainder of the region, particularly northern New England, experienced substantial changes in personnel in response to a more favorable legislative climate for natural resources. Staffing increases of 50% or more in recent years were reported by some agencies, but these were described more as remedies of past deficiencies than indications of prospects to come.

A similar appraisal of federal government employment could not be undertaken because the administrative regions of federal agencies rarely coincided with New England boundaries. With less than 5% of its land in federal ownership, New England should not profit much from increases in federal employment.

Finally, it should be noted that indirect governmental employment, especially among teachers of the public school systems at the local level,

will require people with a broad understanding of environmental issues throughout the New England states in the years ahead, and that the growing demands of the recreation industry, especially in northern New England, will also increase the demand for individuals with a solid grounding in environmental studies.

How well are other colleges and universities in New England, already engaged in environmental programs, meeting this potential for employment? I will be frank to say that in the recent past, proliferation of new programs has seemed far from rational. It is no accident that a close examination is now underway in Massachusetts by the Board of Higher Education, or that a similar analysis will be conducted shortly for New England as a whole under the joint auspices of the New England Regional Commission and the New England Natural Resources Center. I cannot commend you too highly for the careful evaluation now taking place within your own institution.

We do know that in the field of professional resources training—specifically, general forestry, wood technology, range management, wildlife management, and recreation—New England institutions graduated 87 bachelors, 35 masters, and 6 doctoral degree recipients in 1967. These statistics, plus the estimates of future needs projected earlier, would lead one to conclude that another professional degree-granting program in New England would hardly be warranted.

Discouraging though the direct employment prospects may appear to be, it is obvious that there are some very important environmental educational jobs left to be done. Agency heads and industry administrators have spoken with some concern of the growing shortage of trained sub-professionals. For example, it is literally impossible to find experienced woods-workers or recreation managers in many parts of New England. A limited market, therefore, appears to exist for the two-year technician—but, hopefully, so trained that his career is not dead-ended at this level.

Another favorable topic among administrators is the alleged inadequacy of much of the professional training instilled in even the accredited institutions. This raises, to me, the intriguing prospect of alternating work-study programs leading to a professional resources or environmental sciences degree. This would be similar to the cooperative education approach so successful in the engineering field. The student could thus learn on-the-job, garnishing his theoretical background with a

touch of reality. The rapport between intern and employer would, more than likely, constitute a self-generating force for future employment.

Unless I am mistaken, however, neither of these possibilities would seem to fully challenge the extensive resources of Dartmouth College.

Another area of potential educational need involves those already engaged in the practice of their profession. The complexities of modern decision-making require the skills, experience, and scope that few professionals now enjoy.

For example, in its recent study of environmental education throughout the United States, the Daddario Committee received affirmative responses from more than 500 institutions, but could identify barely a hundred that seemed to have a truly interdisciplinary program. Most were addressing themselves to graduate students only, and the few undergraduate programs available were devoted primarily to teacher training. In almost every instance, the actual degree was still granted by a single department.

Many of us recall with nostalgia the old Littauer program at Harvard, supported for so many years by Resources For The Future—also the so-called Forest Production Conferences sponsored by the Harvard Forest at Petersham. During my period in state service, probably the most useful event for me was the series of annual sessions organized informally by and for the heads of the consolidated natural resources agencies across the country, and held about this time of year in some remote but otherwise appropriate setting. This deliberate non-organization enabled us to exchange ideas, unburden ourselves of pressing problems, and generally recharge our batteries for the fray back home.

New England could certainly utilize a program of this nature for selected graduate students and career professionals focused on broad environmental decision-making. The material should be heavily case-oriented, the faculty drawn from several institutions, and the program itself inter- rather than intra-university. Recognizing the differences in geographic area, a program each for southern and northern New England could perhaps be justified or, possibly, an institution flexible enough to move from campus to campus. I would regard Dartmouth as eminently qualified for such an assignment.

Sketchy as these statistics and observations have been, a picture does seem to emerge concerning the New England region and Dartmouth's possible role in environmental education.

First, New England's natural and material resources base, never really bountiful from the beginning, will represent a continually declining factor in the region's future economy. It would, therefore, seem a serious mistake to predicate any new program on a substantial prospective market for skilled technical professionals.

Second, New England's principal economic growth and, correspondingly, its major career opportunities, will probably develop in the non-extractive and non-manufacturing categories. For example, a three-fold expansion is projected for construction; a four-fold increase for insurance, real estate, and government employment; and a four-and-one-half-fold rise for the business and private services sectors. Thus, to obtain the maximum impact from any new venture, Dartmouth must plan to go where the action will be.

Third, unless the experts are sadly mistaken, New Englanders will enjoy appreciably higher per capita incomes, demand a higher level of social services, increase their spending for such non-commodity pursuits as recreation, and exhibit a deepening concern for the environmental amenities.

Finally, the spotlight may well shift from southern to northern New England where the resources are still relatively unspoiled and the economic opportunities still largely underdeveloped. If so, Dartmouth will be precisely where the action is expected to take place.

I, therefore, conclude that an undergraduate program, leading to a minor in environmental sciences, is the most practical course for Dartmouth to pursue. Its aim would be to inculcate in future citizens, regardless of their eventual vocations, an abiding respect and concern for the environment. As teachers, businessmen, professionals, or just plain laymen, they would have countless opportunities to perform environmental services of the highest magnitude; for it is the ordinary citizen that usually holds the balance of power in any critical environmental decision. Simply stated, Dartmouth's aim should be to make the ordinary citizen, extraordinary.

Can the resources be found to sustain such a program? I believe the answer is strongly in the affirmative.

In the first place, much of it would be self-supporting—through tuition income, use of existing facilities, and redefinition of existing course curricula and faculty assignments. I foresee no need for elaborate facilities, for Dartmouth lies within easy reach of the greatest outdoor labo-

ratory in the northeast, the famed White Mountains region and the Connecticut River Valley.

The modest supplemental funds required could well be raised within the region itself. For example, in the New England region alone there are at least 500 charitable trusts and foundations among whose stated purposes is the support of higher education. According to The Foundation Library Center, their combined reported assets exceed $600 million in the last year of record with some $38 million distributed in outright grants. More than one hundred of these charitable organizations were company or industry-sponsored institutions. Nearly one out of every four dollars expended by foundations, nationally, in grants was in support of higher education. Nearly $4 million was allocated specifically to conservation in 1966, and the proportion is expected to increase sharply in the future.

In summary, then, I have painted at times a bleak but hopefully realistic picture of New England's future in relation to natural resources. The trends appear to favor growing urbanization, continued decline in extractive and manufacturing industries, and a surge of new growth in what are generically described as its services components. The most hopeful signs, natural resource-wise, are the growing locational importance of the region's environmental amenities and the emerging insistence of its public on improved environmental quality.

Northern New England's awakening concern for proper land use, and the coming economic development thrust in this portion of the region, seem to offer a particular challenge to Dartmouth which I, for one, hope it will accept. An aggressive program to advance simple environmental citizenship, aimed at the undergraduates who will shortly inherit both our resources and our problems, would represent a refreshing and exciting approach, in my judgment, and a project of immense significance to the region.

III. CONFERENCE ADDRESSES

Man and Nature on a Collision Course

GEORG BORGSTROM
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KANSAS STATE UNIVERSITY has in its emblem the following motto: "Governed by the endeavor to control nature by obeying it". This is a kind of rewriting of the famous thesis presented by the philosopher, Francis Bacon, that Man in his own interest should obey the laws and commandments of nature rather than subdue nature. As early as in ancient days, philosophers such as Xenophon and Aristotle expressed similar lines of thought, however, in less articulate form. They underlined the importance of man living in harmony with nature rather than trying to domineer it.

If mankind had shown respect for these timeless truths, the present profound crisis which we now are living through, namely, the confrontation between technology and biology and its basic ground rules would never have occurred. In this context technology is interpreted in its broadest sense and not limited to engineering techniques. Technology is taken to encompass the totality of all of our procedures whether it is a question of capturing fish, breeding grain, fighting diseases in man, animals, or plants, designing machinery and equipment, synthetically manufacturing enzymes or new nutrients, building dams or bridges, or conquering the immense distances across oceans or continents.

In this broad sense, technology embraces both medicine and agriculture, transportation and house construction, only to pick a few very arbitrary examples. The bulldozer and miracle therapeuticals may, for modern times, serve as symbols for this conviction of man's omnipotency—an idea which more and more has come to characterize the spokesmen for modern technology. Man has, they opine, made himself the unchallenged ruler of nature. He has his own destiny increasingly under complete control. Man has further made himself almost independent of nature, its vagaries and capriciousness. The atom bomb, the jet

planes, the gigantic irrigation dams, broad spectrum vaccination, organ transplantations, moon trips and other interplanetary parade spectacles are often mentioned as evidence or even guarantors of this new era in which man is almost the unrestricted ruler. Man's century-long fight to attain control over his environment is symbolized by the air-conditioned, artificially illuminated home, the canopied business arcades, the arctic umbrella cities, subaquatic metropolises and enthralling desert regions with abundant grain fields and luscious jungles created under the protection of huge plastic domes. Almost as pledges for new persistent victories man points to the extension of air-conditioning to such artificial canopies, to be spanned over large sections of the Middle East, over the dry prairies of North America, and in general over deserts and steppes. All water is to be retained within these structures and to be hindered from rejoining the huge hydrological cycle of nature. Air and water within these huge structures is to be purified, renewed, and recirculated through enormous pumps and cleansing aggregates. Man is, in other words, promised a dream world created by technology, governed and controlled by the omniscience of computers, and driven by the limitless flow of energy from nuclear reactors.

I am not going to analyze how tremendously far removed the present world is from these fairylands and to what almost staggering degree we have lost touch with reality. At this stage I will limit myself to accept these anticipated accomplishments and designs as an alleged promise for a future world of marvels—as a kind of world of bliss in being and move to my particular analysis.

First, a reminder that the entire development to which I just briefly have alluded and sketched in very broad strokes, can register its greatest feats in the field of destruction. These creative potentialities of technology have in effect given man the capability of eradicating all life on earth via microbial toxins and to devastate if not entirely blow up the globe via nuclear reactions in bombs, missiles, or otherwise. It is an indisputable fact that death and extinction, thanks to technology and to the gains of science, now is within closer reach than ever before in human history. In lieu of further developing this aspect of the advances of technology, it is my aim here tonight to discuss a much more basic and in one way serious question, namely the fact that man in his efforts to gain absolute power over nature, has initiated processes of such a kind that they rarely can be arrested; in this way he is raising new and serious

threats to his existence on the whole. In other words, his very survival is jeopardized. I will try to use specific examples in an effort to indicate in approximate terms to what degree man in each individual case seems to have passed retreat, or reached a stage where he appears less likely to be able to undo the harm. The changes induced are, in other words, irretrievable and the road back to survival is overpoweringly complex.

Oxygen Starvation

Since the end of the nineteenth century the carbon dioxide content of the atmosphere has persistently been mounting and, in effect, at an accelerated rate. We have created a civilization which at an early stage declared war against the green plant cover of the globe. The forests have been pulled down and other vegetation submitted to overgrazing, frequently to the point of complete destruction. Man has created far more deserts by these processes than he has ever reclaimed through irrigation. Large areas of cities and rural districts have been covered with concrete through vast highway systems, industrial sections, parking lots, airfields, and sportfields. Thus we have strangled parts of nature's oxygen delivery system. Equally ominous is the combustion engine. This has now reached a point where three and one-half billion people are consuming, largely on this count, as much oxygen as fifty billion people through respiration. Leaders in this massive consumption of energy are not more than one-tenth of the world's people. The question now is: Is it conceivable that such a gigantic waste of oxygen could be ten-folded? In other words, is it feasible to arrange for such a luxurious consumption of oxygen by the total world population as is now enjoyed by the economic elite? Or is it likely that mankind will remain content to allow the economic and military nobility to enjoy such a disproportionate share? There is no doubt that mankind has a long way to go to reach suffocation, but, on the other hand, there is no question that we are on a clear collision course. Since 1860 the carbon dioxide content of the air has risen more than fourteen percent and with present rapid refill it is estimated that in the year 2000 one-fourth of the carbon dioxide of the air will have originated in man-controlled processes; this despite the fact that considerable amounts of newly formed carbon dioxide will be captured by the water masses of the oceans. This whole development started with the combustion engine and the ensuing increase in the consumption of fuel, such as coal and petroleum. In 1967, seventy billion gallons of gasoline were used

each day. In the combustion of one ton of gas, one and a quarter tons of water are obtained as a by-product and almost twice as much of carbon dioxide. A jet plane of type 707 produces these huge quantities each tenth minute. In New York more than 10,000 non-military (commercial) planes land each week.

Oxygen is now consumed at a rate which widely surpasses anything previously known in the history of mankind. At the same time we persist in destroying the vegetation over increasingly larger areas, completely unaware, it seems, of the fact that all oxygen on earth originates in the photosynthetic activities of the green plant cell. It is calculated that each year the United States is placing under concrete and asphalt cover in excess of one million acres. In the western part of the Union there seems now no other recourse left if further millions are to be accommodated, than to resort to a complete removal of all vegetation in the watersheds of the rivers in these areas. Man can no longer afford to allow the water to be used by what is classified as non-useful vegetation plants, so called "phreatophytes"—water robbers. Water is desperately needed in the cities but in particular on the irrigated, food-producing lands. To this degree is man, in that part of the world, on a collision course.

Groundwater Depletion

One percent of the rainfall in Arizona replenishes the aquifers but no less than 70% of all water used in the state has its origin in these same aquifers; 15,000 acre-feet are taken by day, and the water table is persistently dropping. On the whole, the U. S. Southwest is pumping itself into underground drought, yet still more people are moving in with infinite faith in some kind of benevolent Santa Claus for water.

Both Southern Texas, as well as Central and Southern California, have in sight the end of tapping ground-water resources. The groundwater level has now fallen so deep that pumping to the surface is becoming increasingly uneconomical. In many places, not the least in the San Francisco Bay area, sea water is already seeping into the continent in considerable quantities and this despite the immense transfer of water on a multi-billion-dollar scale which now is taking place and often means the transporting of water thousands of miles. Even on Long Island, out in the Atlantic, water consumption is so excessive as to cause ocean water to seep into the substrata.

As a long range possibility for the Southwest, the tapping of the water resources of the Yukon and the Mackenzie basins now remains only as a final recourse. This gigantic project of the North American Water and Power Alliance is estimated to involve an investment of two hundred billion dollars. The water of the Yukon River is to be led to a storage pocket in the Rocky Mountains, located in British Columbia. From this dam, water is to be carried to California and to the entire water-needy southwestern part of the United States. Some water is planned to supplement the resources of Mexico, now close to complete depletion. Its agriculture and industry need large additional quantities. Some of the water might go into a replenishment of the Great Lakes basins, now starting to become severely strained to a degree which, unless something radical is done within a few decades, will jeopardize the present St. Lawrence Seaway.

Living organisms influence, through their life-processes, all natural cycles but only at a very slow rate: man, with the aid of technology, has gained supreme power and capability to interfere drastically in these cycles of nature, both as regards time span and order of magnitude. Man's intervention, in several respects sudden and profound, has created large disturbances in nature, the consequences of which we have been very tardy in noting. The disruptions now threaten to become so enormous that nature's own cycling is menaced.

In particular four elements are major ingredients in all living mass, namely carbon, hydrogen, oxygen, and nitrogen. They are each of them, both independently of each other and often together, involved in continuous cycling between living organisms of many categories, mammals as well as microorganisms, forest trees as well as marine algae. Sometimes they appear in the air or water, and sometimes in waste products. Some of them are captured for a longer or shorter period in geological formations or in the glaciers of the poles or in the high altitude mountains.

The Nitrogen Cycle

Nitrogen commands a special position, as this element more than others gauges the quality of life, being the main ingredient in protein, the basic substrate for life and all living tissue. Human poverty, poor health, and malnutrition can all be traced back to this common denominator. Ni-

trogen is, furthermore, the most important ingredient in a number of key substances in living organisms, such as nucleic acids, enzymes, hormones, and several vitamins. The feeding crisis of mankind is in one way basically a nitrogen crisis.

Let us take a brief look at this crucial nitrogen cycle. The United States has an annual overall biological turnover of nitrogen amounting to seven to eight million tons of nitrogen per year. Modern technology throws into this cycle no less than seven million tons of nitrogen, largely through chemical fertilizers. Cars and thermo-electrical plants contribute via air pollution another two to three million tons as a further load. Consequently, it is a question of a tremendous overburdening of, or rather, intrusion into the domain of nature—with its natural nitrogen cycle. It is rapidly becoming clear that nature and technology are on a clear collision course in this respect.

The biochemistry of nitrogen is characterized by the rareness of oxygen compounds and the dominance of hydrogen compounds. In the cycling of nitrogen, nitrate and nitrite consequently are merely ephemeral phenomena. Man's interference constitutes a massive injection of precisely such nitrogen-oxygen compounds into the soils via fertilizers and as pollutants in water and air. The microorganisms of the topsoil convert most of these artificial fertilizers to nitrate and nitrite. During the last twenty-five years the United States has fourteen-folded its uses of nitrogen fertilizers and three-folded the amount of combustion gases from cars. Europe has in the last twenty-five years increased the use of nitrogen in agriculture three and one-half times and the Soviet Union eight times. To this should be added almost as a corollary a direct human intrusion through sewage pollution, persistently mounting and carrying a high nitrogen content.

The maintenance of low concentrations of oxidized forms of nitrogen is crucial to the integrity of earth's life systems—its functioning is jeopardized when such compounds are artificially raised, a kind of tampering with unexpected consequences. Rivers, lakes, and other waters are already overloaded with excessive amounts of nitrate, inducing waterblooms and quick eutrophication. Some waters rapidly fill in with growing plants and the end result is that the water flow is severely disturbed, if not completely upset. Oxygen shortage is soon felt, in turn resulting in rapid death of fish and other life depending on oxygen.

Air Pollution

In daily life we give little thought to the fact that most volatile detergents, cleansing materials, hair sprays, insecticides—in effect everything we release into the air—remains there if some microorganism, plant, or other living creature is not capable of picking them up and of converting them into innocuous substances. Presently, the United States atmosphere receives around 360 thousand metric tons of detergents per year merely through so-called dry cleaning, i.e., chemical laundering. These compounds differ greatly in their persistence (i.e., their time of residence in the air and later in the ocean); presumably they persist for a very long time.

With regard to carbon dioxide the efficient green plant cells are not capable via their photosynthesis, as already has been underlined, of keeping up with man's inadvertent carbon dioxide fertilizing of the atmosphere. Worse than this, however, is the fact that many directly toxic substances reach the air, such as carbon monoxide, hydrocarbons, nitrogen oxides, sulfur oxides, etc. Innumerable particles reach the air such as phenoxibutyl from tire-rubber.

At the present, twenty-six million tons of sulfur are mined each year but at the same time no less than twenty-eight million tons of sulfur dioxide are each year emitted into the atmosphere. New York receives per year 600,000 tons SO^2 and Los Angeles, 176,000 tons. This frequently results in local destruction of green plants, of lung tissue, as well as in the corrosion of iron structures.

Is not nature itself, as well as each individual organism, in effect a multifaceted chemical plant, capable of synthesizing infinite numbers of organic compounds? Does it really play any role if man releases some of his man-made chemicals into the air or into the oceans? This is the key question.

DDT

Fish-eating birds, in fresh-waters or in the sea, have become the vulnerable final victims of the build-up of DDT within the lengthy production chains of the waters, which starts with plant plankton and then moves further along. DDT is converted to a closely related substance, DDD, the content of which rises approximately in the following way: in plant and animal plankton one finds up to 10 ppm, but in plankton-

eating fish the amount may rise four to thirty times up to 40 or 300 ppm. Large predatory fish belong to the later links; at this stage, DDT is further accumulated up to 1500 ppm, and finally, fish-eating birds are found containing 2000 to 5000 ppm. A number of birds have fallen victims to this "long distance" destruction such as the peregrin falcon, the northern red shouldered egret, and, not the least, the bald-headed eagle. Already the fish are disturbed in their metabolism and suffer. Quite recently very high DDT figures were discovered for the fish of the Baltic. Thousands of pounds of coho salmon from Lake Michigan were seized in the spring of 1969 due to their DDT content. In the British Isles, mother's milk turns out to have 30 times higher content of DDT than cow's milk. In West Germany and Switzerland the amount of DDT in carrots frequently exceeds established limits. DDT sprayed in human conglomerations and crops moves via the atmosphere out over the oceans and enters into the feeding chains of these waters via plant plankton. Consequently, it is not so much of what is carried as effluents by the rivers and other run-off but rather what is airborne which causes trouble. This load moves directly into the plant plankton, the primary producers of the seas, and from there into the lengthy aquatic production chains.

Most serious, however, may not be the fact that rare birds become extinct or even that the fish become unsuitable as human food. Far more ominous to man's future is the detrimental effect of the photosynthesis of the plant plankton. If this basic food producing mechanism of the oceans, supporting the entire life pyramid of the oceans, is deranged the consequences are disquieting, to say the least, and could well become disastrous. Studies in the Pacific Ocean show that its diatoms which there dominate the phytoplankton react towards DDT by a 30 per cent reduction in their photosynthetic activity. In this way not only productivity of the oceans could be negatively affected but an important source of atmospheric oxygen (around 1/3) would be seriously jeopardized. More than half of the oxygen of the air originates with these small helpers of man in the big factory workshop of nature. If these research findings are confirmed, it is quite possible that we will be facing a direct two-edged threat against human existence on the whole. The basis for life in the oceans would also flounder. This is so far only a warning, but it is quite conceivable that we in this respect are on a very serious collision course.

Natural fresh waters, such as lakes, rivers, and dams, are in several important industrial countries already passing out of food history due to their overloading with waste products. They are no longer productive in terms of fish as food. This is true of Europe, USSR, and USA, and is also affecting an industrializing country like Japan. The chemical barriers which we have built and recommended to raise around the rice crops of the world further reduce the possibilities for the raising of fish crops in the paddy fields. This procedure has for centuries rendered invaluable supplementary protein food to the hundreds of millions living in those areas where wetland rice is being grown.

Ocean Contamination

The common conception prevails that the oceans, covering two-thirds of the surface of the globe to an average depth of four kilometers (2.5 miles) are so enormous that they hardly can be affected and much less polluted more than locally, as for instance through oil. In fresh memory is still the wrecking of the Torrey Canyon oil tanker off the coast of Southern England, and the California leakage in connection with oil borings along the South California coast in the summer of 1969. I would like to remind you that only a fraction of the so-called oil incidents are in effect reported to the public. The truth is, however, that man, basically a land animal, presumably can be said already to exert a greater influence on life in the oceans than any of the thousands of species which now live there. Man has not only contributed a greatly accelerated transfer to the oceans of soil, minerals, and organic compounds. He alone is responsible for the addition to the rich arsenal of the oceans of innumerable new chemical products.

So far, it has been the air surrounding us which has taken the largest share of the radioactive fallout from atom bombs and hydrogen bombs. In the next stage, in the era of nuclear reactors, the oceans are in line as global diffusion media. The rare element of ruthenium is one of the radionuclides from the waste effluents of the British Windscale reactors, north of Blackpool. This element is accumulated in some red algae which for ages have been dried and made into a powder as a bread extender in Wales. Among the Eskimos in Alaska the radioactivity rose in the food due to radioactive cesium which turned out to originate from the meat of the caribou. This in turn received the hot molecules from lichens where cesium was enriched or built up from the fallout from the

air. We believe we have averted any further complications on this front as well as the risk of being on collision course through our bans on nuclear testing. But the reactor effluents remain. This new loading of the oceans is only its start.

Lead, mercury, cadmium, and many other elements are some of the entirely new pollutants which through this channel reach the oceans. The annual production of mercury by industry is around 9,000 tons. Mercury salts are largely used in agriculture and industry; actually half of this amount reaches the oceans via rivers and the atmosphere. Both mercury and cadmium have caused serious poisonings in Japan. Methyl mercury, the chief culprit, is accumulated in the feathers and livers of birds. Oysters and fish both accumulate this very toxic compound and aggravate the situation for others by forming new organic compounds of this unpleasant metal. Some fishes carry this mercury back to the real culprit—man. The air in some US cities is contaminated with mercury; this surprisingly enough even in San Francisco, particularly when smog appears. The risk of mercury is well known in many parts of the world but it now turns out that it could also be a factor in some mental disturbances in big US cities, very much like the professional occupational hazards which earlier affected the makers of hats and the workers in tanning and leather plants.

Lead Hazards

Since tetraethyl-lead was introduced as an antiknock agent to liquid fuel forty-five years ago, the ocean has received most of its lead from this source. Each year the air in the northern hemisphere receives no less than 356,000 tons of lead. In La Jolla, the air load of lead is ten times lower than the average of US cities, but 100 times higher than on the wide air expanses over the Central Pacific. This amount of lead has three-folded in the northern ocean waters since 1900, but so far not reached, as far as we know, any toxic level; but its amount continues to rise. The average North American now carries 125 times more lead in his body than when the car first came on the technical scene, hardly seventy years ago. The amount is all the time climbing irrevocably up towards the established tolerance limits. The amount of lead in the ice of the polar caps has grown towards the surface layers of the glaciers. In this way we get a distant registration of our oil-borne civilization. In a similar way, the green plant cover from crops growing in proximity to

the major highways in the motorized world show a higher amount of lead, hardly, however, ever reaching toxic levels; although the truth of the matter is that we do not know with certainty where the risk limit is and far less what the effects are of suboptimal amounts. The intake in the human body of more than one milligram lead per day is, however, considered a hazard to health.

Mineral Oils

A cardinal point in water pollution is that caused by mineral oils. As already hinted, it is quite arbitrary what reaches the newspapers in this regard. The wrecking of "Torrey Canyon" in southern England in 1968 and the oil leak outside of Southern California are only a few incidents among a whole set of similar ones. A barge carrying one million gallons got loose from its mooring at the coast of Delaware a year ago. It drenched the main natural bathing facilities most frequently used by the citizens of the city of Washington. A pumping hose burst and a quarter of a million liters of gasoline spread over the California Bay. A tanker broke apart in the Panama Canal at Christmas time last year (1968). A huge Japanese tanker was grounded in the heavily trafficked strait of Narato, south of Tokyo with gasoline flowing out in tremendous quantities. In addition, one could cite a number of wrecked ships and other accidents during recent years where the oceans have taken the fatal impact of oil. The entire coastline of Rhode Island was drenched with oil at the time of the latest presidential election. The origin of this oil, whether from a ship or a plant, has not even been traced.

Despite legal prescription as to procedures to follow in the cleaning of tanks (e.g., that no such cleanup is permitted unless 100 miles off the coast), the amount of oil reaching the oceans with the present volume of oil transporting and the growing use of oil is a serious matter. Merely in the cleaning operations and through vessels moving across the seas an amount of oil is leaking out which is fully adequate to cover the entire surface in less than seven years. This is a phenomonon entirely apart from the accidents just discussed. In other words, this routine cleaning of tanks constitutes a major source of oil pollution and yet this operation is allegedly supposed to be under satisfactory control.

But all of this does not free us from the responsibility for mankind's future. Still less can we sustain the attitude that we are controlling our destiny and that our technical civilization is under control. Our con-

ceited attitude is most conspicuously evident in the loud assurances which now and then are given that ships driven by nuclear power are entirely without risk. Accidents and human mistakes once again have vanished from the picture.

Oil is a basic prerequisite for our energy provision whether in homes, plants, schools, offices, airplanes, ships, cars, or thermoelectric plants. The present world consumption of oil, largely in the hands of 20 to 25 per cent of the world's people, has seven-folded since 1938 and most of this has to be shipped over long distances.

Chemical Barriers

Man has been fairly convinced that he lives comfortably behind alleged impenetrable chemical barriers, but several of man's foes and the hostile forces he encounters are such that he is forced to wage a persistent battle for his survival. He is constantly encountering less susceptible, more resistant strains both of plants, microorganisms, animals, picked mainly through nature's own selection. More crucial is, however, the fact that our ruthless chemical campaign or chemical warfare is not selective. We eradicate indiscriminately friend and foe alike, as we take over this policing in nature. Holding our enemies at bay has, as a consequence, become excessively expensive and onerous.

There are, in effect, no finite victories in the power struggle of living nature. We have presumptuously boasted about how we have defeated one after one of the great enemies of mankind: locusts, tuberculosis, malaria, smallpox, etc. The truth of the matter is that we are all the time involved in a fierce, relentless battle for survival. Constantly perilous breakthroughs occur in our defense systems, believed to be impenetrable.

Malaria has, as you well know, reappeared on the world scene in new forms after having outsmarted not only our effective new malaria therapeuticals, and this in regions which for a long time have been considered as cleaned up, as for instance Ceylon and South Vietnam. Furthermore, entirely new species of mosquitoes resistant towards our insecticides have emerged, also as vectors of these disease agents.

The cotton plantations of the world are currently in many places threatened by invasion from new damaging insects. The number of sprays required in modern plantations has constantly increased and has now reached the almost unbelievable number of thirty to fifty sprayings per growing season. Despite this, there is great concern that this chemical

protection will end up as inadequate. Both in Texas and Louisiana as well as in Peru the search is on, almost in a feverish manner, for new ways to protect the cotton plant. This example is far from unique, but mirrors very well the intensity of our battle. The bulwark is facing possible collapse despite the fact that our defense efforts have irrevocably mounted.

The truth of the matter is, however, that man is involved in a very hard defensive battle in order to protect and sustain the existence of himself, his livestock, and his crops. This is the truth of man's condition on earth. This picture contrasts deeply with the persistent victory reports read almost daily in the news media and professional journals.

Let us once again make it perfectly clear that these observations are in no way construed to belittle the enormous importance of our chemical weapons and their very impressive contributions to agricultural technology, veterinary hygiene, and medicine, and which are of considerable benefit to mankind. The error committed lies in the mistaken notion that our advances were final. Most of these have been temporary in nature. We have constantly been forced to raise the level of our defense preparedness by the magnitude of our countermeasures. It is therefore quite possible that as a consequence we should seriously consider changing our tactics, as well as our strategy. Our present chemical warfare does not safeguard human existence and must simply be reappraised.

International Dimensions

Finally a few general comments. The world is in more than one respect one single world. The radioactive fallout reaches the whole globe and affects not only nuclear powers. The pollution of the oceans is spreading to all waters. The effects of what we do as dirtifying agents is affecting also the cleanest and most innocent among the peoples of the world. Unfortunately, in addition, many of the damages we have inflicted are not reversible. Is there a better argument for the need for man to move out into one single world? We must shoulder our world responsibilities. Perhaps the International Court of The Hague in this particular regard has neglected a very cardinal field of activity. We must begin to recognize these world responsibilities of ours and also to respect the rights of other peoples. This is the more imperative as we have started to hurt ourselves, primarily with regard to environmental prerequisites. The United Nations Commission for Human Rights has, despite its multitu-

dinous number of meetings, never managed to move down from its abstract, verbal world and to formulate in real values what it takes to provide man with nutrition, acceptable food, clean air, and first-rate water.

Point of No Return

In transoceanic flights one reaches the point where the crucial fuel is nof sufficient for returning to the starting point. This is called the point ot no return. There is then no way of getting back to the airfield from which the flight started. The overshadowing question of today is in how many respects we have, as a collective mankind, already passed this fatal point. Are we in a position to restructure the globe and restore the plant-covered acreages we have converted to deserts? Can we give back to the earth all of the topsoil which we, through thousands of years, have destroyed and expended? Can we restore the forests which we have ravaged in all continents? Can we return the hecatombs of water we have tapped from ground water resources without replenishment and in this way used to fill up the oceans? Presumably not. What we possibly could accomplish is to achieve a new balance by putting a brake to further accumulation of our man-made waste in air and water. We could further, if we so desire, put a stop to the continued destruction of the plant cover and topsoil. Under all circumstances we are forced to reduce our ecologically absurd accumulation of wastes by moving them into this circulation. Our sewage plants need to be converted into centers for food production with algae, mushrooms, fish, insects, quail, ducks as final or intermediary end products.

Man has shown very little respect for life in other shapes than himself. Yet, most living organisms seem to have a special function and man's future may very well hinge upon one or the other of these either unknown or underrated species. It is basically not a question of conservation, but rather a restoration of nature's circulation to get rid of our dumps and their loads. In nature everything is constantly changing to secure survival.

Man has, however, become the most redundant mammal. Tigers and lions can nowadays be counted in the tens of thousands. Man has created an overdeveloped world due to excessive deforestation, tapping of groundwater, and overextended grazing. There are, as a consequence, close to one hundred million ecologically displaced persons in the world.

Man is truly an ecological superfactor. Hundreds of animals and

plants have become extinct under his onslaught. Whale hunting represented a frightful carnage in both the northern and the southern oceans. There was a time when some kinds of whales seemingly did appear in all waters of the globe. The blue whale is now declining under man's heavy onslaught and any year we might get a report about its vanishing. At the best we deplore this, shrug our shoulders, "too bad", or we are merely bored and express our indifference by yawning. If Mona Lisa is lost, airports are put under surveillance and security forces around the globe are mobilized to retrieve the lost masterpiece. Besides the loss of many hundreds of plants and animals, clearly invaluable also to man, we are furthermore throwing away in our self-confident attitude, irreplaceable genes which in the future could be crucial to our survival. How would Shakespeare and the masterpieces of literature look if certain words were deleted, or what would happen if we decided to remove any particular instrument from all symphony orchestras? We do not seem to appreciate in the right manner the fascinating interplay of the ecosystems of living nature. Their colors, odors, and genetical code messages make these systems function.

Crop sprays may certainly remove one species of a detrimental beetle but in the process several spiders or insect-eating birds, our helpers in nature, are also doomed. To chemists all organisms seem to be classified as vermin by myopic statements such as "there were only pests killed and the chemicals did not damage the crops". Toxicologists look at things primarily in terms of dangerous levels but pay less attention to suboptimal or collateral effects. Most ecosystems in nature have been simplified by man and in this way been made most susceptible to disturbance in their regulating powers. Man reduced diversity and thus created lower stability and greater vulnerability for life, inclusive of his own.

The Paradox of Power

Miracle medicines and bulldozers have been held forth as power symbols. Technology will, however, be forced, step by step, to learn a lesson that life constitutes such a potent force in nature that it cannot be held imprisoned or under absolute control. Man of technology, the sovereign master of techniques, the ruler of the atom, and now with the added honorary title of the conqueror of the moon, is so conscious of his

power that he has become completely unaware of his powerlessness, his weaknesses, and his vulnerability. It is high time we discovered the dangerous course we are following which undoubtedly could lead to ecological catastrophe.

The false notion that nature only exists to serve man is at the root of the major ecological crisis towards which we are now moving. This largely western concept is thought to have its basis in the Bible, according to which man not only was endowed with divine forces but also held the full right of claiming ownership to the entire creation. These kinds of ideas have very few counterparts among the people of the Orient. They never embraced any such false notions as that man could be in a position to subdue nature. On the contrary, they have always looked upon man's earthly life as precarious. Man was a guest, a visitor upon earth, who at best could be given a hesitant welcome to the big household of nature. Generous invitations to the banquet of life sound hollow to the hundreds of millions for whom life is nothing else than a terrible vigil of death. Western man will have to teach himself to work with nature, not against it, and to respect the basic fundamental laws of nature. Man must start to look upon himself as part of a tremendous ecosystem and make it completely clear to himself that man is not master, nor is he a slave. An omnipotent mankind does, in effect, carry in itself the seed to its own destruction. The ingenuity of nature and delicately balanced interplay between all living creatures is a mighty divine framework, the structure of which cannot without reproach be broken down, taken apart, or destroyed.

Man's particular tragedy is, however, that at the very moment when both thinking and action in these regards are being revamped and adjusted to the realities of the globe, man himself is facing tremendously mounting demands without precedence in the entire history of the human race. At the same time a minority of the world's people are trying to put into practice on a worldwide scale a civilized regard toward energy and water as well as raw materials, both renewable and non-renewable. Yet this is not the whole picture. We are to such a degree irresponsible that we have thrown ourselves into one of the most spectacular armament races in human history. USSR and USA together with their allies now have military expenditures which per year exceed the annual costs in World War II when at its peak. No one seems to be questioning our ght to dispose of the resources of the world in this

thoughtless and reckless way. It can yet on very good grounds be maintained that the real way to reduced political tension and to the creation of a basis for truly peaceful conditions is that all humans join hands to live together and cooperate in waging a grand scale war of quite another kind, this to secure man's survival. Our fate is otherwise to be read as in an open book. Ladies and gentlemen—the writing is on the wall in our festive hall; our days are counted. We are forced to switch courses and to establish new priorities for human endeavor. We witness a technology which is going astray among space vehicles, atom bombs, continental missiles, and computers. We see a science which in its specialization has lost sight of the wherefore of its strivings. Mankind's vessel is truly on a collision course. The lookouts up in the mast have given us many warnings, and collective mankind must change its course to avert catastrophe. Man is truly on a collision course. "If future generations are to remember us more with gratitude than with sorrow, we must achieve more than just the miracle of technology—clear water and sandy beaches are a nation's real treasures" (Theodore Roosevelt).

Environmental Dialogue

The New Education

GERALD S. WITHERSPOON
President, Goddard College

I CAME here, as perhaps you did, because I'm interested in the life expectancy of my children, in the survival of man upon the earth. Species become extinct and new species evolve, I am told, for a variety of reasons. In the past, the causes of extinction, so far as I am aware, have not included the folly of a species itself. But we have somehow managed to foul our own nest, to make our home increasingly uninhabitable for ourselves and other forms of life. Our starting point in this conference, therefore, was a frighteningly simple one: our continuation upon the earth has become problematic. Something must be done. Can anything be done? The question, of course, is what—if anything—can be done to preserve life here.

Dartmouth's response to the problem thus far has been a good one: to plan the creation of an interdisciplinary program in the environmental sciences. Indeed, I see in that strategy the seeds of a revolution in higher education.

For several centuries European and American universities have been organized around the disciplines into which the Greeks, and later the medieval churchmen, divided human knowledge. That organizational scheme profoundly affected the nature of higher education's work and mission in the world. For example, so long as a department stayed within the bounds of its historic discipline and met certain conventions of scholarly activity, almost any topic of research or teaching was acceptable to the academic community. If the goal, after all, was the accumulation and dissemination of abstract knowledge, research on germ warfare was as appropriate for a biology department as was the discovery of penicillin; the development of a missile guidance system was as legitimate for an engineering department as the building of a new bridge. And in determining priorities among such diverse activities, it

was reasonable, and, perhaps, inevitable, that the availability of outside funding for particular projects should be the determining factor.

But interdisciplinary programs seem to me to operate on very different premises. Lacking any historical or traditional organizing principle, such programs are organized typically around a problem which has captured the imagination of the institution. In deciding which activities shall fall within or without the boundaries of such a program, the test is a pragmatic one: is the activity relevant to the solution of the problem at hand? The challenge is equally pragmatic: one must follow the problem where it leads until a satisfactory solution has been found.

What, then, are the roots of the ecological problem around which the environmental sciences program has been organized? What is the source of the threat we perceive to the survival of mankind? One of the tasks of the program, of course, is to answer just that question. But we must begin with some hypotheses if we are to know where to look.

Part of the problem is surely human ignorance—the lack of scientific knowledge. We apparently didn't know until the last five or ten years, for example, the long-term effects of the use of DDT and other pesticides on animal life. And it was even more recently that calculations have been made suggesting the catastrophic effects that the sinking of a ship loaded with DDT would have on the world's ecological balance. We don't yet know, and perhaps don't care, from all appearances, whether the continual defoliation of Vietnam's forests and the poisoning of its rice fields will permanently affect the ability of that unhappy land to produce crops, should anyone be left to need them when the war is over.

Even strictly scientific research, however, may have a special style and flavor when put to the service of ecological survival. Gone will be the boundless optimism which characterized science's age of innocence. At Hiroshima, if not before, we ate of the fruit of the tree of the knowledge of good and evil. No longer can we afford to make anything we know how to make, for part of the threat to our survival comes precisely from run-away or mindless technology. To paraphrase Wittgenstein, science and technology are the disease of which they must now become the cure. Part of that cure may lie in slowing down the pace of technological innovation, in buying time to reexamine results and implications, in simplifying rather than further complicating technical systems; in beginning to work with, rather than seeking always to domi-

nate nature. We must proceed with caution and humility, as befits the all-too-human managers of a fragile and exhaustible spaceship Earth.

But if we concentrate solely on scientific research, we will surely fail in our ultimate purpose which was, you will recall, to insure the survival of a suitable environment for life. The truth of the matter is that we already *know* better than we *do*. We already have the knowledge to eliminate scores of environmental threats, any one of which could jeopardize our survival.

What then is missing? Partly the promulgation of existing ecological information to a public which is unaware of the dangers it faces. One of the most exciting aspects of the plan for Dartmouth's new environmental sciences program, thus, is the attention you have given to the problem of public education.

Let me suggest, however, that effective education in this area may be very much more difficult than we recognize. People who most need to learn about these matters seldom attend conservation conferences. They certainly don't read scholarly journals. If we leave all of the effective media of communication—films, TV, popular magazines, even comic books—to the sellers of beer in aluminum cans, or of pollution-belching automobiles, or of non-bio-degradable detergents, we shouldn't be surprised if the bad guys win the day and if the human race turns out to be the loser.

Having said all of these things about the importance of further research and public education, I'm still not sure that we've identified the most important sources of the threat to our environment or that we've designed a strategy realistically capable of meeting that threat. Let me explain my concern this way.

A century or two ago, the thoughtless actions of *individuals* posed such dangers to the environment as existed at the time: the clearing of vital forests by early settlers, the cultivation of future dust bowls by homesteaders moving West. These environmental dangers took on deadly proportions, however, precisely as such individual action and autonomy itself became a smaller factor in all aspects of the nation's life. Ours is now a nation of giant governmental and business institutions. They, not individuals, control most of the economic resources of our society, organize and direct most of the productive labor of its members, even determine the consumption and leisure patterns of most individuals. Before the development of such concentrations of power, our

environment had at least a fighting chance to survive. Now the odds have shifted dramatically the other way.

What is the mechanism of this enlarged threat and how can we address ourselves to it? Part of the problem is institutional size itself. Giant corporations and government agencies are made possible by, and further promote the specialization of labor which characterizes a bureaucratic society. That specialization of function within the institution diminishes, in turn, the responsibility of any individual for the ultimate outcome of institutional behavior. The problem seems particularly acute, or perhaps just especially visible, in the case of scientists and engineers who appear so often to be cheerfully complicitous with their institutional employers in the destruction of the environment. In all events, technicians are encouraged by the entire structure of their productive activity to believe that the ends they serve are properly established by some "front office" somewhere. As Tom Lehrer sings, "Where missiles come down is not my department, says Werner Von Braun".

An urgent task of Dartmouth's new program, therefore, may be to reconsider the relationship between scientists or technicians and the institutions which direct most of their labor. Hope for a new level of ecological responsibility, in this respect, may lie in Paul Goodman's proposal for the professionalization (in the original sense of that term) of the functions of scientist and technician in our society.

But the problem with institutions goes deeper than I have yet indicated. Most of the institutions which dominate the life and ecology of America do not even purport to be answerable to the public for the social results of their behavior. We *celebrate* the fact that our business corporations serve only the profit motive and the financial interests of their shareholders. To be sure, there is the official doctrine about Adam Smith's guiding hand which makes everything turn right in the end. . . . Which guarantees under circumstances which never seem to obtain that private greed will, in the aggregate, add up to the public interest.

But I submit that this most sacred of American ideologies is patently false and that its falsity can be illustrated on every side.

For decades General Motors did no auto safety research worthy of the name, despite the fact that more Americans were killed and maimed inside its products than in all of our wars put together. And that richest of our industrial corporations knew about the dangers of auto-related air pollution in our metropolitan centers years before it even began its

desultory research efforts into electric engines and smog control devices.

Our most respectable drug companies charge unconscionable prices for life-saving medications. They palm useless or dangerous drugs off on a gullible public, and squander precious research funds to duplicate and break the patents on each other's products.

The cigarette industry is perhaps the classic case of modern industrial criminality. It continues to scoff at nearly incontrovertible proof of the lethal character of its products. It uses every device to lure young people into the habitual use of cigarettes, and shamelessly blocks or corrupts every attempt of government agencies to protect the health of the nation.

Other examples are scarcely needed. The truth of the matter comes down to this. We have both the knowledge and the resources to eliminate most present threats to our environment, and to feed, clothe, and house decently every member of our society. But it is simply not profitable for the corporations which control those resources and technologies to serve the public interest in this manner. And thus it is not done.

What could Dartmouth's new program do about this stubborn root of our present ecological problems? You might devote your research efforts to increasing the profitability, or diminishing the inconvenience to corporations, of serving the public interest in the environmental area. Much of our pollution research is directed toward that end already. But the price of making survival profitable is high, and most of the bribery systems yet suggested seem remarkably inefficient. You can put beefsteak into a sausage machine as long as you please, but you're still likely to get sausage out the other end.

A more realistic solution might be for some university, for some institute, for some program somewhere in the United States to begin serious work on fitting our economic and political institutions to human needs and human survival rather than the other way 'round.

I would not want to mislead you into thinking that such a task would be easy, however. I would be more comfortable if there were even one serious Marxist teaching in an economics department in the United States, but I'm not hopeful that the Marxists have a solution to our problem. Whatever the experience in Communist countries, our own political institutions have not acquitted themselves any better than our private corporations on the ecological score. Regulatory agencies—like the FTC—which should be protecting the public interest are either so incompetent or so beholden to the industries regulated that they pro-

vide little or no beneficial service. Congress and the state legislators are even more depressing, if that's possible. Can any explanation other than institutionalized conflicts of interest on a massive scale explain the failure of these bodies, year after year, to enact effective legislation on consumer protection, the meaningful control of land development, pollution abatement, billboard elimination, and related subjects?

Perhaps the current interest in Community Development Corporations may hold some promise. Where the owners of a manufacturing corporation are the same people who must drink and breathe its effluents, for example, it is less likely that those effluents will be as toxic as is often now the case.

In all events, the problem of institutional reform for survival is a complicated one. It is rendered all the more difficult by the problems which would surely arise in financing such an effort. The federal government is unlikely to help now that our new administration has limited its interest in free speech to only that sphere which the human voice can reach without electronic assistance. And as if that development weren't troubling enough, we saw last week that the federal response to the largest, and generally most peaceful, demonstration in American history was the threat to jail the demonstration leaders on felony charges, if such could be arranged in the courts.

Foundations might be helpful in financing a basic attack on the roots of our environmental problems. But their fingers were burned on Ocean Hill-Brownsville and they have their own problems with the federal government these days.

Even the wealthy conservationists might desert us in the end, it must be warned. Some may turn out to be warm weather friends when it develops that the price of survival must be shared by all of us, not just the owners of housetrailers, or ticky-tacky houses, or junk yards.

But these are dark thoughts, and it's time to move on to a final point. Thus far I've tried to argue that the price of averting apocalypse—if that's what we're really up to—may be higher than we have supposed. It will take more than a white lab coat, an air of scientific detachment, and a few more articles in the scientific journals. Ecological balance isn't financially profitable or politically sexy, and thus it won't be pursued unless some fundamental changes occur in the popular understanding of these matters and in the institutional structures which govern our lives.

For all the importance of popular education and institutional reform,

however, our conference planning committee was surely right in emphasizing undergraduate education as the focus of our attention today. Institutions, after all, are not disembodied spirits. They are run by an elite corps of managers, administrators, politicians, scientists, and technicians, most of whom were trained by us before they assumed their powerful roles in the society.

Our final concern, then, is a pedagogic one: how do we train effective agents of social change who can stem the destructive tide which threatens our lives and our environment? Part of the answer to that question involves scientific preparation, of course. But enough has been said about that matter today and I have no expertise on the point to add to your own.

This much we can agree on, however. It does no good to train scientists, if their new-found skills end up in the service of the destructive forces we seek to control; or if we school them so thoroughly in the arts of passivity and compliance that they lose all will or ability to resist destructive forces when they encounter them.

I want to focus, then, on a range of educational questions which may be vital to the true success of our efforts: How does one design a program capable of producing people whose values differ significantly from those of their elders; whose basic concern is the public good rather than the special interest? How does one provide an educative experience for young people which facilitates optimal moral growth; feelings of puissance in the face of fragmented, dehumanizing culture; sufficient strength to act creatively in spite of massive pressures for conformity, passivity, and compliance?

Fortunately, the stance of the young today makes this task not altogether impossible. Students in all parts of the world—even right here—have placed themselves on the side of life. In the face of an overwhelming—and well founded—sense of apocalypse, young people stand against all forms of destruction. They experiment, without our help and guidance, in new kinds of cooperation; they resist war, feed each other, drop out of the consumer culture. Their whole life experience has taught them that there is something amiss in the world and that they want no part of many present institutions. These attitudes are a good starting point for the educator. But only a starting point. Our job now is to provide a different kind of experience, not one against which students can react, but one through which they may learn to act positively.

I think the key idea here is experience. If students are to learn to affect the institutions which govern our lives—influence our environment—they must be given the free opportunity to practice full participation in the governance of the institutions in which they receive their education. If students are to learn cooperative modes of action, they must be provided with situations in which cooperative efforts in fact produce positive results which can be experienced as meaningful. If students are to come to understand the economic structure of the society they live in, they must be provided not only with courses in theoretical economics, but with experiences—both small and immediate and much larger in scope—from which they can deduce directly what the economic modes and structures of the society actually are. If communication is important, then students should have access to media on various levels; if group process must be understood, then opportunity must be provided to experience, as well as study, the processes involved in all kinds of group interaction.

How are these ends achieved? Do we design field trips? Provide internships in Senators' offices? Subsidize college newspapers, radio and TV stations? Help students plan and execute relevant projects? All these, certainly, but these are not enough. What we must do, in effect, is turn over to students control of the structures which govern their lives. We must give up the symbolic, make-believe quality of student government, and substitute for it government by students.

I am not suggesting mere anarchy, nor am I unaware that most students initially lack the skills to function effectively in as demanding a situation as I've described. Our job is the more difficult because it involves offering help, the fruits of our own experience, advice on request, without interfering with the basic rights of students to learn by mistakes. We have to find ways of offering real independence without abandoning our young. I suspect our best hope is to engage in an open and continuing dialogue with them, to admit that we ourselves are seeking answers rather than promoting prepackaged solutions, that we, too, need experiences which can reaffirm our humanity, our sense of commitment to life. In such a dialogue, the participants listen to each other, and can, in fact, learn from one another's experience and knowledge.

We must also come to accept a fact which is particularly difficult for teachers to deal with, but nonetheless true. In an Ivy League college

dormitory I visited recently there was a hand lettered sign up over the fireplace which said: DON'T LET SCHOOL INTERFERE WITH YOUR EDUCATION. It spelled out what is becoming more and more evident: that much of what is significant, radicalizing, truly educative in the lives of the young goes on outside of the schools and colleges. It happens in the streets, during intense discussions with randomly assembled friends, during journeys whose original aims were purely recreational. It also happens in broader socio-economic contexts than those we are able to provide within the higher educational setting. It is necessary, therefore, that we begin to view our schools as one of many educational resources, that we accept the total environment as the most effective educational facility, the broadest possible range of associations with the most varied assortment of adults as the optimal human resources for learning.

What I have been suggesting, as you can see, goes beyond the formation of a new department, a new curriculum, or new definitions of faculty roles. It is, instead, a different approach to the process of education; for unless we can devise radically new educative modes, the lessons learned will be the same old lessons. They are not good enough. To save life upon the earth, we must change our way of living here. And we must begin this process by permitting our children—our students—to live in new ways, to learn from their experience those lessons which we ourselves have been unable to learn. With such lessons—and a little luck—survival in a truly livable world may still continue to be possible.

IV. PROPOSALS

Dartmouth Proposal for an Undergraduate Educational Program in Environmental Studies

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IT is eminently clear that Dartmouth College, with its small size, emphasis on undergraduate education, and commitment to a liberal arts education, should not attempt to produce professional "environmental scientists". Rather, the College should do what it can do best: it should open the minds of potential leaders in a wide variety of professions to the complexities and dangers of environmental problems. Dartmouth can make a far greater contribution toward modifying the social-economic basis for our survival by producing many informed and committed doctors, artists, businessmen, engineers, and journalists, than it will by producing a handful of specialists.

To this end, the Environmental Studies Program has been designed not as a major but as a series of interdisciplinary courses to be coupled with any conventional major. In Dartmouth parlance such a block of cohesive courses is termed a "program". This plan also utilizes a College option termed a "modified major" in which two majors are combined. Generally such a modified major consists of ten courses, six in one discipline and four in the other. A modified major is not meant to be just a major and minor combination, but a meaningful blending of two disciplines producing a unique area of specialization. By making a series of environmentally-focused courses (the program) part of a modified major, a student can gain conversance with the variety and ramifications of environmental problems and, to some degree, shape the rest of his curriculum drawn principally from courses in a conventional major.

Program Organization

The Environmental Studies Program is planned to consist of five courses: three to be taken sequentially in the freshman or sophomore year, and

two to be taken in the senior year. Between these two short sequences the student will be fulfilling the disciplinary portion of his modified major with a minimum of six courses, and completing other requirements. The Environmental Studies Program will retain cohesion in this interim through a series of periodic lectures, discussions, movies, etc. A diagram of the chronological organization of the program is given in Figure 1.

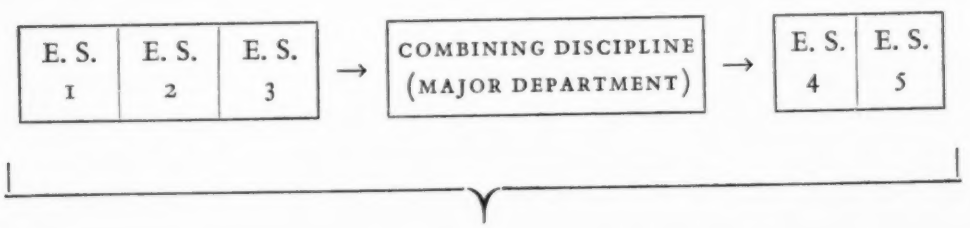

Figure 1. Chronological organization of the Dartmouth Environmental Studies Program. Environmental Studies 1, 2, and 3 are to be taken in the freshman or sophomore years; E. S. 4 and 5 to be taken in the senior year. The block of courses labeled "combining discipline" are drawn from the basic courses of a conventional major in any department in the College. Cohesion of the Environmental Studies Program between the two sequences of E.S. courses will be maintained with a series of periodic lectures and other events.

The first three courses of the program are designed to provide a common orientation and awareness of the kind and scope of environmental problems, and to introduce ways in which various disciplines (bodies of knowledge organized in conventional majors) may lead to useful roles in terms of raising the quality of the human environment.

Environmental Studies 1, *Resources and Man*, will outline the physical and cultural dimensions of some major environmental problems. Selected key resources will be examined in terms of resource demand, supply, and use. Population history, dynamics, and control policies will be surveyed, and the stresses placed on environmental quality by the combined effects of expanding populations and increased per capita consumptions of resources will be identified. Modes of perceiving the environment under various philosophical and cultural systems will be discussed as bases for alternative resource-use strategies.

Environmental Studies 2, *Earth as an Ecosystem*, introduces the concept of our planet as a finite environment with certain properties essen-

tial for life. Many of these properties are of a dynamic nature involving physical, chemical, and biological processes which, in turn, impart an interrelated "system" quality to the environment on the earth's surface. The influences of man, such as global pollution, will be discussed in terms of their effects on this dynamic environment.

Environmental Studies 3, *The Human Dimension of Environment*, traces the development of man, his attitudes, culture, and technology in relation to his environment from primitive times to the present. Major attention is devoted to man's impact upon his surroundings and the cultural, religious, and economic developments that have accompanied the change from an agricultural to an industrial society. The course identifies problem areas in resource utilization, such as pollution, wilderness destruction, and scenic degradation, and investigates modifications in technical and social arrangements that may be necessary to cope with these problems.

These three courses should provide students participating in the program with a good introduction to the nature of environmental problems. At the same time, these courses are open without prerequisite to all students at the College. Thus, a second function of supplying attractive, interdisciplinary courses for individuals with more casual interest in environmental problems is fulfilled.

Environmental Studies 4 and 5, *Environmental Policy Formulation*, are restricted to seniors enrolled in the program. The purposes of this two-term course are: 1) to give students an opportunity to see how the disciplinary knowledge acquired in various modified majors can be fitted together in a synthetic manner; 2) to provide a forum for in-depth discussion of important public problems; and 3) to give students the experience of working in a group toward the solution of a problem.

The format of these courses will include lectures on group interaction, problem identification, and elementary systems analysis. This will be followed by introduction of actual environmental problems facing agencies and local governments. Then, small teams of students representing a variety of disciplinary abilities will examine one of the several problems presented and formulate well-informed policies. While studying their problems, the student teams may request special lecturers or consultants as seems necessary.

As an example, a group of eight students representing modified majors in biology, earth sciences, engineering, geography, government,

English, economics, and art might attack the problem of development of resort property on a hitherto remote lake in New Hampshire. The biologist could prepare the significant data on eutrophication and shoreline vegetation. The economist could make a rudimentary cost analysis of various plans while the government major might gather all the pertinent legal aspects of such development. Other roles can easily be imagined. If necessary, the team might request a conference with a landscape architect, or a limnologist. The final policy would be reviewed by a panel of appropriate experts and, if successful, passed on to the agency which originally described the problem. Upon completion of this two-term sequence, students should have a realistic view of the varied outlooks of persons with different backgrounds, and the constraints imposed on idealistic plans by powerful economic and cultural forces.

Modified Majors

As there are many ways in which an individual can aid in reshaping our social-economic system toward better environmental management, so there may be many disciplines which can serve the individual student to realize an effective role towards accomplishing that goal. A sound background in biology is required if an individual wishes to enter graduate school and eventually become involved in pollution ecology. Similarly, preparation in physics, government, and economics are still necessary for career planning in the professional schools of engineering, law, or business which can eventually lead to roles in environmental engineering, environmental law, or economic analysis.

Far from diluting these classical disciplinary areas, the Environmental Studies Program should illuminate the value of material in a conventional major for a student so that he may dig deeply in this material, rather than skim the surface with complaints of insufficient motivation or "irrelevancy". At the same time, evidence of student interest in applications of material in these areas ought to stimulate instructors to incorporate examples or adjust subject matter so that courses will be more germane to students' philosophical, and perhaps, professional interests. As a practical matter, it is quite likely that students will choose to take more than six courses in these disciplinary areas in order to gain sufficient competence.

As a result, incorporation of the Environmental Studies Program in the Dartmouth curriculum should not be divisive, nor should it distort

the fundamental orientation of a liberal arts college. The interdisciplinary nature of the program should augment appreciation for broad knowledge and understanding fundamental to liberal education. Hopefully, it will inject student enthusiasm for all knowledge taught in a college or university by illuminating its relevancy to human affairs. In this way a liberal arts college may not only serve society with such a program, but will also serve itself.

Williams Proposal for an Undergraduate Program in Environmental Studies*

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The Objective

The objective of this proposal is to establish an integrated, interdisciplinary program in environmental studies within the tradition of liberal education at Williams College.

The program is intended to provide students an understanding of how different disciplines contribute to the study of the environment, with sufficient disciplinary concentration to allow them to rigorously analyze contemporary environmental problems. Program integration is provided by a sequence of core courses that focus on synthesis.

The Program

In order to serve the needs of students with varied degrees of commitment, options within the program are intended to offer opportunities for participation in several different ways.

First, a student in a traditional major will have the opportunity to elect a coordinate-major in environmental studies. This option is intended to provide the student an insight into his major discipline as it relates to contemporary environmental issues and problems. Regardless of the student's future plans, this added dimension of environmental awareness will be a valuable part of his liberal education at Williams.

Secondly, for a limited number of students with a clear commitment, a major in environmental studies will offer a program which could lead to professional environmental employment or graduate study. Flexi-

* The Provost's Coordinating Committee for the Center for Environmental Studies, on December 11, 1969, recommended to the College's Committee on Educational Policy that the coordinate-major portion of this program be initiated in Fall, 1970. Action on the full program was deferred, pending further review.

bility within this option will allow the student to develop an individual program, with the possibility of a joint major in a traditional discipline if desired.

Finally, for the student with only a peripheral interest in environmental studies, a junior-level elective course will be offered which is not part of the regular program sequence. Such a student could also elect courses in the introductory sequence of the program and, if he satisfies the prerequisites, advanced environmental courses offered by the departments.

The program will be under the direction of an Environmental Studies committee composed of the director and assistant director of the Environmental Studies Center, and departmental representatives designated by the Committee for Educational Policy.

The Curriculum

The curriculum consists of an introductory sequence, a concentration sequence, and a core sequence. The following pattern of courses is common to both of the options in the program:

The four introductory courses will be offered in the departments of economics, art, biology, and political science as part of their regular course offerings open to all students. These courses would help to satisfy

distribution requirements, and may also serve as introductory courses for the department.

The first *core* course (ES 300) will be a junior course offered by the Environmental Studies Center, requiring the four introductory courses as prerequisites. The focus of this course is synthesis; a study of the interrelationships between traditional disciplines necessary to an understanding of the complex, interdisciplinary nature of environmental studies.

The *concentration* sequence, composed of courses offered by the departments, will vary depending on the option chosen.

The senior *core* course (ES 401) will bring together all students in the program for a study of environmental policy formation and planning. The final core course (ES 402), open only to environmental studies majors, will provide experience in actual environmental planning.

The Options—Coordinate-major and Major (see diagram below)

The *coordinate-major* option would be taken concurrently with a major in one of the established departments. In addition to satisfying his department's requirements, the student would be required to take the introductory sequence, core sequence courses 300 and 401, and at least one advanced course in his major department which is directly related to environmental studies (to be approved by the environmental studies committee). The advanced course, selected on the basis of the student's interests and available courses, might also satisfy one of the department's major requirements. Examples of such courses, listed in the current catalog, are: Econ 344, advanced ecology, History 341, Geology 302, Philosophy 371, Art 305–306 (or advanced environmental design), Political Science 307, and English 208. Departments would be encouraged to reduce the number of required courses in their major sequence, when appropriate, for a student with a coordinate-major in environmental studies.

The *major* option will require a concentration sequence that serves to develop a rigorous understanding of one aspect of environmental studies, with a minimum of either three courses in one discipline or four courses in two related disciplines. At the time of enrollment in the major the student will be required to submit a list of courses to be included in the concentration sequence, with a statement of the rationale for these choices, to the environmental studies committee for approval. In addition, the major candidate is required to take the major core course (ES

402), and at least one Winter Study Project in environmental studies—offered by the Center for Environmental Studies or cooperating departments.

The curriculum is so designed that a student initially pursuing a coordinate-major could, as his interest and commitment evolve, change to a full environmental studies major or complete requirements for a joint major in both his disciplinary major and in environmental studies. On the other hand, a student pursuing a coordinate-major could drop the program and continue only in the disciplinary major without the loss of time or the compromise of his basic major program. These alternatives are possible because the program is designed to make maximum use of existing courses, with minimum initiation of new courses outside of the existing departments. This design also permits program implementation with minimal interference to departmental prerogatives.

Program Implementation—schedule of new course initiation

First Year—1970–71

Env Std 100 (Econ 100)—planned new introductory course in economics; members of dept.

Env Std 112 (Art 112)—planned new course in art, to be given by planned staff addition.

Env Std 201 (Biol 201)—existing course; Labine/Grant.

Env Std 221 (Pol Sci 221)—planned new course; Reidel.

Env Std 300—with reduced prerequisites until full program implementation; Scheffey and Reidel with participation by instructors of prerequisite courses on a rotating basis (2 each Semester).

Second Year—1971–72

Env Std 401—revision of Pol-Econ 339, Scheffey.

Env Std 301—new elective course without prerequisites, Reidel and Scheffey.

Third Year—1972-73

Env Std 402—new course; members and associates of the Center.

ENVIRONMENTAL STUDIES COURSES*

INTRODUCTORY COURSES

Environmental Studies 100 (Economics 100)

RESOURCE ALLOCATION (Introduction to Economics)

An introduction to the principles of economics stressing an understanding of the manner in which markets function to allocate resources among competing uses, and the various types of market failures which result in improper allocation.

No prerequisites. Members of the Department

Environmental Studies 112 (Art 112)

ENVIRONMENTAL PLANNING AND DESIGN

An introduction to basic design, and to problems in the understanding and criticism of environmental planning. Topics: European and American urban and countryside planning; principal historical periods; effects of social and technological change; planning concepts.

No prerequisites.

Environmental Studies 201 (Biology 201)

ENVIRONMENTAL BIOLOGY

A study of the structure and function of ecological systems. Topics: the physical environment and its coupling to the biological world; energy exchange; biogeochemical cycles; dynamics and interactions of plant and animal populations; the evolution of ecological relationships.

No prerequisites. Grant and Labine

Environmental Studies 221 (Political Science 221)

POLITICS, BUREAUCRACY, AND THE PUBLIC ENVIRONMENT

A study of social, political, and bureaucratic institutions concerned with the planning and manipulation of the public environment. Topics: federalism; bureaucracy and public administration; interorganizational relationships; history of conservation and formation of resource policy.

No prerequisites. Reidel

*These are brief indicative descriptions, not formal catalog descriptions, which will be prepared by the concerned departments.

Environmental Studies 300

ENVIRONMENTAL PERCEPTION AND ANALYSIS

A study of the ways in which man has perceived, conceptualized, and analyzed his relationships to the physical environment. The assumptions and framework of traditional academic disciplines are examined as they bear on environmental studies in a historical and contemporary context. The emphasis is synthesis—an inquiry into the essential correlations and interrelationships between various modes of environmental perception and awareness.

Prerequisites: *Environmental Studies 100, 112, 201, 221* Members of the Center

Environmental Studies 401

ENVIRONMENTAL PLANNING AND POLICY

A study of the processes of environmental planning and policy formation in the United States. Topics: natural resources appraisal and administration; the economic forces, ecological considerations, and cultural attitudes affecting the planning process. Analysis of regional and national environmental policies in an expanding urban environment.

Prerequisites: *Environmental Studies 300* Scheffey

Environmental Studies 402

ENVIRONMENTAL PROBLEMS

Independent and group study under the guidance of one or more members of the Center and associated faculty. The purpose of this course is to integrate and advance the student's knowledge of environmental planning and policy formation through a critical examination of selected contemporary issues and actual experience in environmental planning.

Prerequisites: *Environmental Studies 401*

Open only to Environmental Studies majors Members of the Center

ELECTIVE COURSE

Environmental Studies 301

An elective course for students not participating in either the major or coordinate-major program in environmental studies. A study of the basic concepts of the humanities, social sciences, and physical sciences fundamental to environmental planning and management. A review of conservation history and changing attitudes toward the natural environment.

No prerequisites. Junior course Reidel, Scheffey

(Not open to students with a major or coordinate-major in Environmental Studies.)

ENVIRONMENTAL STUDIES PROGRAM

WILLIAMS COLLEGE

Env Std 100 (*Econ 100*) Resource Allocation (Introduction to Economics)

Env Std 112 (*Art 112*) Environmental Planning and Design

Env Std 201 (*Biol 201*) Environmental Biology (Ecology)

Env Std 221 (*Pol Sci 221*) Politics, Bureaucracy and the Public Environment

Env Std 300 Environmental Perception and Analysis

MAJOR OPTION

(a) Three courses in a single discipline

or

(b) Four courses in two disciplines

WSP in Environmental Studies

Env Std 401 Environmental Policy and Planning

Env Std 402 Environmental Problems

COORDINATE-MAJOR OPTION

Major requirements in a discipline, with at least one advanced course in the major directly related to environmental studies

Env Std 401 Environmental Policy and Planning